THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
The Institution of Electrical Engineers	215
Coast Communication	216
Compound Engines for Electric Lighting	216
Electric Lighting Plant at Lambton Castle (*illustrated*) ...	218
Electro-capillary Phenomena and Differences of Potential on Contact	218
Researches on Decomposition of Ores by the Electric Current ...	219
Magnetic Rotation and the Dissociation Theory	219
Electrical Underground Conduits (*illustrated*)	220
Electrolytic Caustic and Bleach.—More about Electroculture ...	223
New Mode of Employment of Continuous Current Transformers	224
The Comparative Cost of Gas and Electricity	225
London County Council	227
Mr. Livesey and the Electric Light	228
Review:—Universal Office Manual	228
Notes	228
Business Notices, &c.	233
City Notes:—India-Rubber, Gutta-Percha Company	234
Newcastle and District Electric Lighting Company ...	235
Birmingham Electric Supply Company	235
Gülcher (New) Electric Light and Power Company ...	235
Share List of Electrical Companies	236
Iridium	237
Electric Lighting in Berlin	238
Mr. Tesla and the Drehstrom System	239
Protection from Lightning	239
Royal Commission for the Chicago Exhibition, 1893	240
New Patents.—Abstracts of Published Specifications	241
Correspondence:—Mr. Tesla's Experiments	241
Electrical Organ Control.—Aurora Borealis	242
Crystal Palace Electrical Exhibition (*illus.*)—(*continued*) ...	243

J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1892,

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THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE proceedings at the meeting of this Society on Thursday last week had a good deal of the unexpected in them, as in the first place, owing to the announcement that Mr. Siemens's paper was to be read so as to be discussed conjointly with Mr. Preece's, members were rather led to expect that the two papers were on the same subject; and it was therefore somewhat of a surprise to find that but a small portion of Mr. Siemens's paper was devoted to points connected with the insulation of conductors. It is, we think, a matter for regret that the first and larger portion of this paper should have been read at the last meeting, as the subject of insulated conductors affords ample scope for a prolonged discussion, and no advantage can be gained by the introduction into the same discussion of matters connected with transformers, which, indeed, might well claim an evening to themselves. Again, we were told that Major Cardew would probably open the discussion at the next meeting, by describing a new method of measuring high resistances, thus introducing another subject of great interest and importance, and one which it may be supposed that many of the members would like to discuss. It is true that there is some connection between the measurement of high resistances and insulated conductors; but surely it would be better to deal with a new method of making these measurements at another time, as it is practically impossible for any one to do justice to the three subjects we have mentioned in the time which is usually allotted to each speaker.

Reverting to the proceedings at the last meeting, a new departure, as we believe, was made by the announcement, after the reading of Mr. Siemens's paper was concluded, that those present might, without commencing the discussion, ask questions of the author concerning any points in the paper which appeared to require further explanation. This seems to us an excellent way of occupying the short space of time often left after the reading of a paper, as it may clear away misunderstandings, and so start the discussion on a future occasion on a clear basis; but, unfortunately, two circumstances combined at the last meeting to make the opportunity less useful than it might otherwise have been; namely, that the paper was not in the hands of members at the time of the meeting, and when mathematical formulæ and tables of figures abound, it is extremely difficult for any one to appreciate their full meaning by hearing them read out only; and, further, that through the unavoidable absence of Mr. Siemens, the answering of the questions that were asked had to be deferred to the next meeting.

At the close of what may be called question time, Mr. Preece rose to read out a paragraph he had added to his paper since it was given last year. The postscript contained the most important statement in the paper, and one which it is difficult

to reconcile with much that had been said in the original communication. It will be remembered by those who heard or read the paper, as published last year, that Mr. Preece told us that all we wanted to know, so as to be able to define the quality of an insulating material, was its specific insulation; and a considerable part of the paper was devoted to showing how much more convenient it would be to deal always with specific insulation on this account, to the description of a new practical unit, and to data concerning the specific insulation of various dielectrics. Now, however, Mr. Preece tells us in his postscript that durability is at least as important as insulation, and that he has very little confidence in the durability of materials which give a specific insulation much above the normal. Both statements will no doubt meet with their share of criticism in the discussion, but it is to be hoped that to prevent misunderstandings a definition will be forthcoming of what is the normal specific insulation, as the term appears somewhat vague, in view of the fact that figures are given in the paper for one material alone, which range from a little over one to nearly twenty.

We note that Mr. Preece suggests a test for durability which may be applied to vulcanised rubber, but that none are given for any other materials; and we hope that information on this point will be forthcoming either from the author of the paper, or during the discussion, as it is on this question of durability that we are in most need of further data.

COAST COMMUNICATION.

THE *Western Morning News* has recently published some admirable articles on this subject by its Special Commissioner, who has spent some weeks visiting and collecting information from coastguard officers and men, from lifeboat coxswains and crews, from lighthouse and lightship keepers, and from pilots. These articles appear also in the *Times* from an occasional correspondent.

We are glad to notice that the comments we have made from time to time do not appear to have been lost. While speaking of the Fastnet Rock cable, the Special Commissioner says:—"It is extremely doubtful whether, in the light of later knowledge and experience, the best possible means were taken to preserve the cable from injury, and whether, if the experiments were tried once more, science and engineering would not be able to overcome all the difficulties."

These articles should do much to further the matter and bring one and all to see that a great national scandal needs to be remedied. It is sincerely to be hoped that the various authorities and departments will work together to secure this end, if only for humanity's sake. The Admiralty, the Board of Trade, the Post Office, the Trinity House, the National Lifeboat Institution, and shipowners, must all work hand in hand.

Apropos to shipowners, the President of the Chamber of Shipping of the United Kingdom, when speaking of the matter last week, after having made the ridiculous statement that communication with many lighthouses probably meant tunnels under the rocks, is reported to have advised shipowners to be careful that this cost should not be added to their already heavy burdens. It should be apparent to the meanest intellect that anything which can be done at a reasonable cost to lessen the loss of life and property around our coasts must be beneficial directly or indirectly to the owners of that property. That the expenditure which would be required to establish communication between all our coastguard and lifeboat stations and with our principal isolated lighthouses, would not be warranted from insurance purposes alone, is quite possible. The principal thing is the safety of our sailors, and to provide for this as far as possible we look to the State. That shipowners, merchants, and underwriters should be asked to contribute, is only reasonable. Indeed, many of them have admitted that they expect to derive substantial pecuniary benefit from the carrying out of the proposed scheme.

We believe there are contractors who would be willing to carry out the necessary work in a public spirited way, and be content with very bare profits. The Telegraph Construction and Maintenance Company is said to have already expended a considerable sum of money in the cause, and although the expenditure may not have been attended with signal success, it has been the means of showing us that there is reasonable hope of successfully establishing communication with our lightships; and that communication with rock lighthouses is not generally to be efficiently maintained by the employment of the usual types of cables. Engineers are beginning to think our ordinary types are perhaps not suited to these special requirements, and only last week we published a description of a new form of armour, sent to us by a correspondent, which seems to have many advantages attached to it. The Silvertown Company, which laid the hitherto successful Tory Island cable, did the work, we believe, on specially reduced terms, and there are other wealthy and powerful companies who would not lag behind if they were given some encouragement.

COMPOUND ENGINES FOR ELECTRIC LIGHTING.

A GOOD deal has been written, and a good many opinions expressed, with reference to the most economical type of engine to be used for central station electric lighting. Opinions, however, appear to be fairly unanimous as to the waste which is bound to occur if the supply of power is effected by large engines of the compound non-condensing type. Economical as these engines are when running at, or nearly at, full load, a most marked, not to say serious difference is observable when the demand for the power falls off. Carefully compiled statistics, and suggestive graphic representations of the data, have given a very clear idea of the varying requirements which may reasonably be expected as regards the demand for light during the 24 hours period from any central station, and from these the ingenuity of the engineer should be able to work out a consistent scheme for generating the power with a maximum of economy. Very few would, we imagine, ever entertain the idea that inasmuch as large compound engines are said to be highly economical, therefore this means that one immense machine, with possibly another for a stand-by in case of accidents, would be the most desirable arrangement to adopt. The plain fact remains, that when working at full load, compound

condensing engines (or non-condensing engines in cases where the necessary supply of condensing water cannot be cheaply obtained) are by far the most efficient, whilst where a small amount of work only has to be done, the high-pressure high-speed has the pull. The whole question is, therefore, a nice compromise of the various conditions, the further questions of space (as regards the rental) and the cost of a number of engines, as against the cost of a smaller number of the same total power, being taken into consideration. The general principle of dividing up the work, in the absence of storage, into as many units as possible is the one to be aimed at, so that as the work increases or diminishes the power may be added to or diminished unit by unit, each unit working at its best. What the limit of sub-division is, has yet to be decided, losses and gains have to be balanced, and the conditions for a maximum economy worked out. Excessive sub-division is obviously uneconomical from almost every point of view. No sub-division is equally bad, and very wasteful. A 100 H.P. engine will when running without load indicate 10 to 15 H.P. at least, all of which is practically waste. In a particular experiment made, it is stated that the first 10 H.P. required 587 lbs. of water per hour, while each additional 10 H.P. only required 137·5 lbs., and this only shows a part of the total loss. Probably a maximum of economy is reached in the case of the gas engine, where, immediately the engine stops running, all consumption ceases, but at present questions of power, size and space absolutely prohibit its use for central station purposes. There seems to be a great deal to be said for the use of accumulators in central stations, as they enable the best form of engine to be always worked at full load, the surplus energy generated beyond the maximum requirements at any time being accumulated, and then distributed as required when the engine has ceased working. This question then becomes one of the cost of accumulators as regards their depreciation and as regards the loss of the transformation of the energy. Mr. F. King, in a letter to *Engineering*, says that at the Chelsea Electricity Supply Company's station, he endeavoured to carry out a plan which would enable the engines to be used for about fourteen hours a day in the winter, and six to eight hours a day in the summer, and during the whole of the period when the engines were running at all, they would be working under conditions of maximum load.

The objections to such a scheme, which were founded on the generally-conceived loss entailed by the use of storage batteries, have, he states, proved to be fallacious, that is to say, the economy obtained by using engines on full load outweighs considerably the loss in transformation in the secondary battery.

Further, it has been placed on record that in a station like that of the Kensington Company, the average output for the year is only 12·8 per cent. of the maximum output, and, says Mr. King, it does appear ridiculous that at times when the demand is perhaps only ½ per cent. of the maximum load, all the paraphernalia of the central station must be in full operation, and one unit of the power must be kept at work.

Electricity or Electrics?

ONE of our transatlantic contemporaries has been calling attention to what it calls the "fact" that the science relating to electricity has no name of its own; and we are not sure that it is not right, although there is no particular demand felt for any change, at least on this side of the water. It is proposed that the science now known as "electricity" should be called "electrics." The pair of words "electrics" and electrician would then be in analogy with optics and optician, mechanics and mechanician, mathematics and mathematician, and many others. At present the word electricity performs two functions similar to those which are separated in the case of light and optics, sound and acoustics, &c. The Americans have shown themselves rather adept at inventing new words, and have been rather successful in grafting them into the English language, and not in all cases to the advantage of the "Queen's English." We hope they are not going to interfere with the language of science; we will allow them to enrich the language of slang as much as they please. If our scientific words are all to be cast in the same model and everything is to end regularly like the cases in a latin declension, then we think the editor of "Our Language" will grow gray with sorrow if he attempt the task. Let us assume, as he apparently does, that -ic and -ician are desirable terminations, then we will present him with the following specimens, zoologics and zoologician," "astronomics and astronomician," "philologics and philologician," "entymologics and entymologician." We notice that the science of heat has already been called thermotics!

A Canard (?) about Mr. Edison.

THERE is always some story going the rounds of the newspapers about Mr. Edison, who to the man-in-the-street is generally the embodiment of all nineteenth century progress, and consequently must endure the circulation of all kinds of pure *canards* for the special delectation of this ubiquitous individual. One of the latest stories about Edison (or is it an old friend going the rounds again) is, that he denounces all patent laws and patent offices in the "blankest" of terms, asserting that patents have never been of any value to him. We can understand Mr. Edison or anyone else speaking his mind even in "blank verse" on the subject of patent laws and the circumlocutionary ways of the patent offices in various countries, but we doubt very strongly whether he ever calmly asserted that patents had been of no use to him. If so, it must not be taken seriously, but rather, as an unguarded remark, dropped in a fit of irritation under peculiar circumstances. For the various companies, great and small, which have enabled Mr. Edison to prosecute his investigations could not have been commanded without patents, and, so far at least, he has been a beneficiary of the system. On the whole, it would have caused us less surprise if he had been reported as saying that without patents on his inventions he would have made no progress at all.

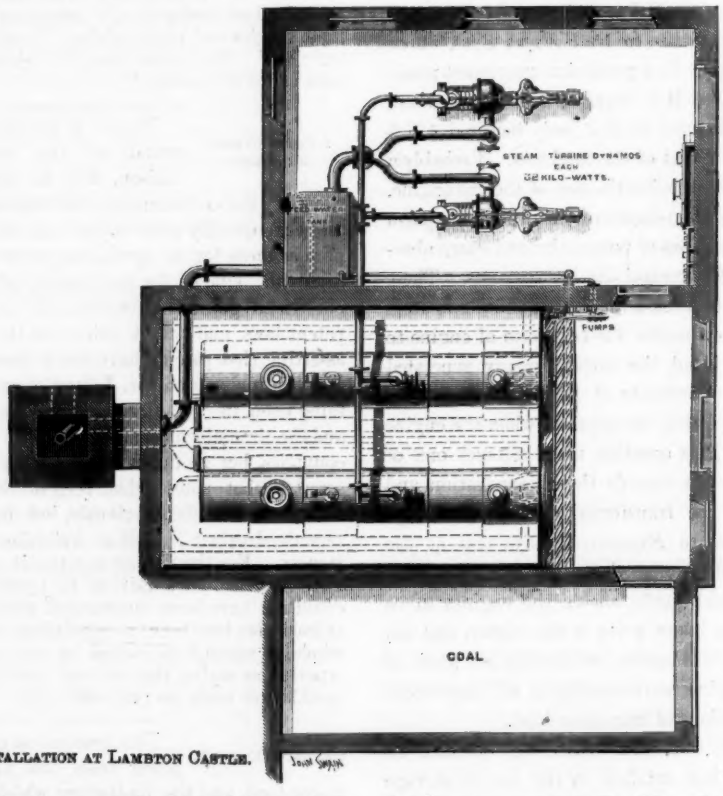
Gas Engine Economy.

THE economical conditions for obtaining power from coal are daily becoming more understood, and the limitations which govern the possibility of a high yield being derived by means of the steam engine seem to have nearly been reached. It seems certain that as regards economy the gas engine has a great future before it; to obtain an indicated horse power-hour from one pound of coal is a grand achievement, but that it can and has been done is indisputable. So many trials of motive power have, when carefully analysed, proved to be misleading that one looks with suspicion when statements of increased economy are put forward. An eight hours' trial of a 60 H.P. (nominal) gas engine (worked by Dowson gas) recently made by Mr. Dowson is interesting. The consumption of fuel during the run amounted to but ·883 lb. per I.H.P.-hour, whilst 52 lbs. of water, for all purposes, were required. The usual deductions for "this" and additions for "that" are made in the calculations, but there is no reason to suppose that these have not been fairly dealt with, so that the general result must be regarded as very satisfactory for the 170 I.H.P. produced. Whether the dimensions of the engines can be reduced there is as yet nothing to indicate.

ELECTRIC LIGHTING PLANT AT LAMBTON CASTLE.

WE illustrate a new electric lighting plant that has recently been completed for the Earl of Durham, at Lambton Castle, by Mr. A. A. Campbell Swinton, which, as will be observed, forms a very compact arrangement.

The two engines are the latest type of "Parsons" steam turbine, direct coupled to the dynamos, which are shunt wound. Each set of engines and dynamos gives 32,000 watts, at a pressure of from 115 to 150 volts, as may be required for working direct, or charging the accumulators, so that the combined power is about 85 electrical H.P. The turbines run at from 4,000 to 5,000 revolutions per minute, and the flow of the steam while doing its work is radial instead of parallel to the axis, as was the case in the older forms of the "Parsons" machine. Each turbine is fitted with a control governor, designed to maintain a constant E.M.F. at all loads; this governor, which is electrical in its action, works by admitting the steam in puffs of longer or shorter duration as is required for the load, this arrangement producing an equivalent of automatic expansion which greatly increases the economy of the engine when running



PLANT OF INSTALLATION AT LAMBTON CASTLE.

below full load. In order to prevent the intermittent action of the steam from causing a fluctuation in the lights, the turbine is fitted with a fly-wheel, which by its momentum maintains a practically constant speed.

The two Cornish boilers are 24 feet long by 5 feet 6 inches diameter, with single flues 3 feet diameter, and are designed to work at a pressure of 100 lbs. per square inch.

The exhaust steam from the turbine is employed to heat the feed water, the steam being simply blown into the feed water tank just below the water inlet, which is provided with a ball valve. The steam finally escapes through a pipe up the chimney.

This arrangement, though unsuitable for ordinary reciprocating engines, which require internal lubrication, is found to answer very perfectly with the steam turbine, as in the latter the steam does not come into contact with the oil. It is found in practice that the water is very quickly heated up to the boiling point.

In addition to the plant illustrated, a battery of 120 accumulator cells have also been provided, capable of maintaining 220 60-watt lamps for 9 hours, or up to 400 such lamps for a shorter period.

The wiring of the Castle, which was originally carried out some years ago, has been largely reconstructed, the total number of lamps being at the same time increased to about 900. A pair of new mains, each containing ·45 square inch section of copper insulated with vulcanised India-rubber, and drawn into 4-inch cast iron socket pipes with inspection boxes at intervals, have also been laid between the Castle and engine house, a distance of some 350 yards.

The re-construction of the wiring, as well as the new plant, has been arranged throughout by Mr. A. A. Campbell Swinton.

ELECTRO-CAPILLARY PHENOMENA AND DIFFERENCES OF POTENTIAL ON CONTACT.

IN view of the controversy that has centred round the question of the differences of potential at the contact of metals, Mons. Gouay, of the Paris Academy of Science, has recently proposed to measure the superficial tension of more or less polarised liquid amalgams, by comparison with that of mercury.

The apparatus used by Mons. Gouay consists of a capillary electrometer constructed with a large tube graduated in millimetres; a lateral tubule and a movable reservoir are provided, which enables the level of the mercury to be varied at will, and in such a way that a single reading gives the height of the column balanced by the capillary forces. The lower vessel is arranged in the usual way and contains mercury and water acidulated with sulphuric acid; it communicates by means of a syphon with another vessel also containing acidulated water and mercury, the latter being distinguished in the paper describing the research by the letter, M. The mercurial column and the mercury, M, are connected by means of platinum wires with a quadrant electrometer, which gives the difference of potential, δ. The height which corresponds to the various values of δ can be measured by bringing the meniscus to a very small and known distance from the end of a tapering point.

This apparatus is dismounted and the mercury completely expelled by aspiration, and then replaced by the liquid amalgam which it is desired to examine, but the mercury, M, remains, and does not vary. The quadrant electrometer is connected up and the measurement of the mercurial column performed as before.

The mode of making the experiment presents no real difficulty, provided that the tapering point be kept bright, and that only negative polarisations be used.

The first experiments performed by Mons. Gouay, dealt with amalgams containing $\frac{1}{1000}$th part of zinc, cadmium, lead, tin, bismuth, and gold, The amalgam of silver used contained $\frac{3}{1000}$ths of this metal. Copper was not tried, because at ordinary temperatures mercury only dissolves traces of it. He demonstrated that *for the same value of δ, the heights of the mercury and of the amalgam are practically the same.* The specific weights being almost identical, it follows that for the same value of δ the superficial tension is the same for mercury and the amalgam ; hence the following law may be enunciated :—

In a system composed of non-polarised mercury, water acidulated with sulphuric acid, and an amalgam containing $\frac{1}{1000}$th part of some metal more or less polarised, the superficial tension of the amalgam is a function of the apparent difference of potential, δ, between the amalgam and the mercury, and this function remains the same if the amalgam be replaced by mercury.

This function is not known for the amalgams on a range as great as for mercury ; one of the limits is the point when it becomes difficult to eliminate the bubbles of hydrogen, and the other is determined by the fact that only negative polarisations are in general employed. With gold, silver and bismuth, there are two branches of the curve, and a maximum is indicated ; this is also attained with tin and lead, but cadmium, and more especially zinc, exhibit extended curves. For these two last metals it appears to be fair to state that the curve would continue to coincide with that of mercury, if it could be determined up to the maximum. Thus the same value, δ_0, of the apparent difference of potential corresponds to the maximum of the superficial tension for mercury and amalgams of the above strength.

These results are important consequences, if it be admitted with Helmholtz and other eminent physicists, that at this maximum, the difference of potential is *nil* between the metal and the acidulated water, L. In fact,

$$\delta_0 = \text{Pt} \mid \text{Hg+Hg} \mid \text{L+amalg.} \mid \text{Pt=Pt} \mid \text{Hg+Hg} \mid \text{L+Hg} \mid \text{Pt},$$

when $$\text{Hg} \mid \text{amalg.} = 0$$

Admitting Helmholtz's theory we arrive at the conclusion that *the difference of potential at the surface of contact between the mercury and the amalgams ($\frac{1}{1000}$th strength) is nil or extremely small.* We know that the amalgams are generally equivalent for the electromotive force to richer amalgams and to the metals themselves. In spite of that, however, it is not possible to generalise the preceding law, for very concentrated amalgams behave slightly differently.

Mons. Gouay's experiments relating to this, not being quite concluded he gives the following example. The amalgam made by dissolving one part of Darcet's fusible metal in four parts of mercury has a maximum for $\delta_0 = -1^\circ \cdot 03$; whilst for mercury it is $\delta_0 = -0^\circ \cdot 88$. Hence according to the views of Helmholtz

$$\text{Hg} \mid \text{amalg.} = +0^\circ \cdot 15.$$

This apparently contradicts the results of other experiments. According to a relation due to Lippmann when an insulated metal falls by drops into an electrolyte it arrives at a potential, takes the maximum superficial tension. But zinc amalgam, as is shown by the tension curve, falls in dropping to practically its normal potential.

Mons. Pellat, to whom we owe much of our knowledge in this branch of research (*vide Journal de Physique*, 1887 and 1890), has observed this fact about zinc and has pointed out other analogous instances from which he has drawn the natural conclusion that zinc amalgam is practically at the potential of acidulated water and that accordingly the difference of potential at the contact of the amalgam with mercury is of the degree of a volt.

But these phenomena are capable of receiving another interpretation. Lippmann's theorem supposes that the spontaneous depolarisation is negligible, whilst for amalgams of oxidisable metals this depolarisation is very great for positive polarisations that are even very small, so that the amalgam on dropping arrives not at the potential which takes the maximum superficial tension, but to the potential at which depolarisation commences to become very active. Hence there does not appear to be any real contradiction between the interesting experiments of Mons. Pellat, and the facts recently established by Mons. Gouay.

RESEARCHES ON THE DECOMPOSITION OF ORES BY THE ELECTRIC CURRENT.

ABOUT two years ago, E. F. Smith showed that the sulphur in metallic sulphides was converted into sulphuric acid by the action of an electric current : that, for example, the whole of the sulphur in copper pyrites might be completely oxidised in a short time by this method, and that at the same time the oxide of the metal might be eliminated, and the sulphate obtained free from the impurities that usually occur. The method can also be applied to the decomposition of iron pyrites, zinc blende, cinnabar, galena, argentite, molybdenite, antimony sulphide orpiment, jamesonite, enargite, stephanite, kobellite, fahl ore, tin pyrites, and other ores of the metals.

Copper glance (redruthite) resisted all attempts to completely oxidise the sulphur, repeated reversals of a very large current only resulting in the oxidation of about half the sulphur. We notice, however, that Smith in conjunction with D. L. Wallace, has recently succeeded in completely oxidising this sulphide, using the electric current, the essential conditions to success being the presence of a large quantity of potash and the prolonged action of the current.

We should like to hear that this method was likely to assume commercial importance, but there seems no probability at present, as may be judged, perhaps, by the apparatus employed, which essentially is as follows :—

A nickel crucible contains the ore, finely powdered, and constitutes the cathode, whilst a strong platinum wire dipping into it forms the anode. The other parts of the apparatus are, a battery, a "resistance," consisting of a wooden frame on which about 150 metres of iron wire are stretched, for regulating the amount of current, a commutator and a Kohlrausch's ammeter, which is inserted between the commutator and the crucible. The "resistance" and the commutator are essential parts of the apparatus, since different sulphides require different amounts of current, and in some cases it is necessary to reverse the current, because a considerable quantity of metal becomes deposited upon the crucible and encloses particles of undecomposed ore.

MAGNETIC ROTATION AND THE DISSOCIATION THEORY.

IN our issue for February 20th, 1891, we gave some account of the opinions of W. Ostwald on the subject of magnetic rotation. As may be remembered, this scientist considered that the unexpected results obtained by Dr. Perkin in his investigation on the rotatory power of solutions might be explained by means of Arrhenius's electrolytic dissociation theory ; and, at the same time suggested that the rotatory power of the ammonium salts of weak acids would probably show marked deviations from the calculated values.

Dr. Perkin, however, in a research which we noticed in the ELECTRICAL REVIEW for November 27th, 1891, has been led to believe that deviations of the magnetic rotatory power do not exist in the cases suggested by Ostwald, the actual differences being very small and comparable with those attending the formation of the ethereal salts of the same acids.

This, at first sight, looks like a "slap in the face" for the dissociation theory, but Ostwald, whilst confessing that the conclusions of Dr. Perkin are contrary to his expectations, has now communicated a paper to the Chemical Society in which he appears anxious to point out that the fault is his and not that of the dissociation theory, so the disciples of the latter "may breathe again."

According to the dissociation theory, the condition of a substance is very different according as it can act as an electrolyte or not, *e.g.*, sodium chloride in the solid state or in aqueous solution ; hydrochloric acid dissolved in amylic oxide (in which case it is a non-electrolyte), or in water, &c.

In the case of the magnetic rotation of the haloid salts, the differences foreshadowed by the dissociation theory are apparent as very considerable differences from the calculated values, and, inasmuch, as Ostwald's former views did not take any account of such differences, he argues that he was

right in saying that the dissociation theory is alone in accordance with Dr. Perkin's observations.

The value for oxy-acids also differs from the calculated values, though in a much less degree; and Ostwald expected such differences to be manifest also in the case of ammonia and the fatty acids, but Dr. Perkin has shown that the differences are quite insignificant.

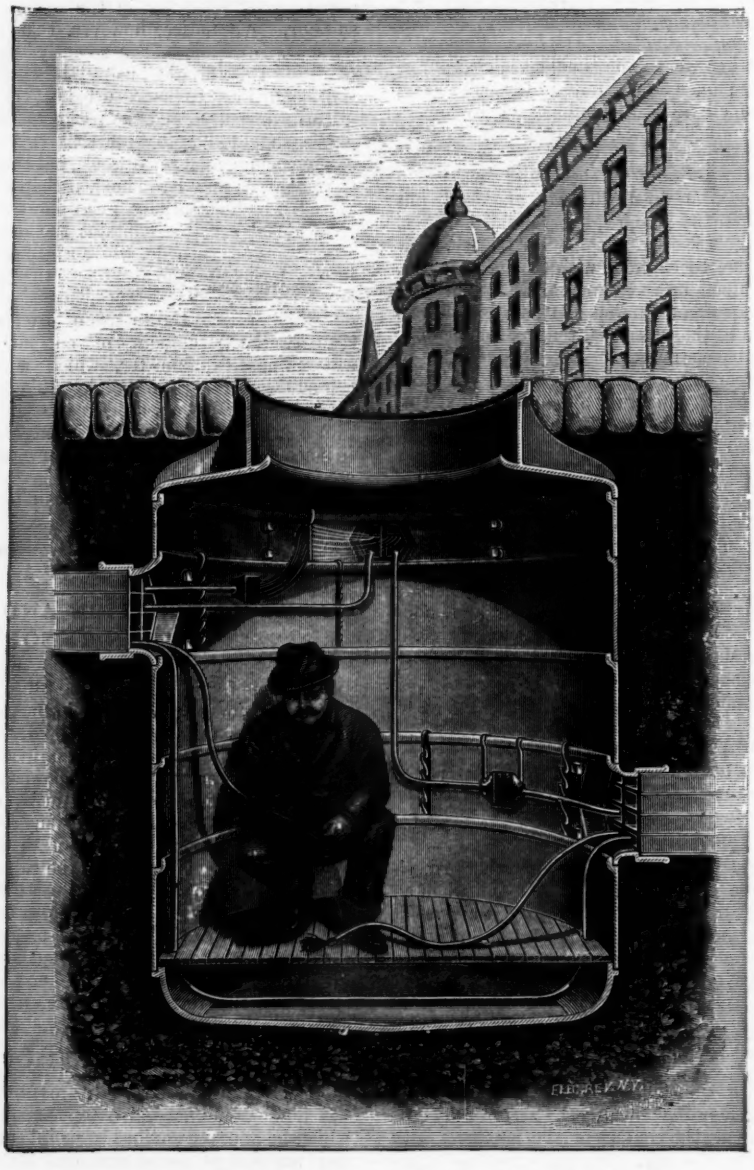
As the dissociation theory does not lead to any numerical value or sign of differences, the very low values observed by Dr. Perkin in the case of the fatty acids are not contrary to the theory, but, according to Ostwald, suggest only the interesting question: on what qualities does the sign and the value of the variation of magnetic rotation attending the transition of non-electrolytic molecules into ions depend? in the case of haloid acids and salts, the variation is positive; in the case of the oxy-acids, negative: therefore it is not surprising that molecules with nearly zero variations are also capable of resistance. Any investigation of a great number of such cases will certainly throw light on this question.

A short method of testing whether Ostwald's attempt to explain the facts of magnetic rotation by the dissociation theory is tenable, would be the following:—

As the greatest differences are observed in the case of halogens between the ionic and non-ionic state, an investigation of electrolytes containing halogen atoms, but not as ions, appears to promise most, *e.g.*, the salts of mono-, di- and tri-chloracetic acids, or chloric and odic acids, potassium mercuric iodide, &c. If in all these cases abnormally high values should be obtained for the halogens, then probably Ostwald would not hesitate to confess that he had been on a false track.

ELECTRICAL UNDERGROUND CONDUITS—JOHNSTONE'S SYSTEM.

THE International Electric Subway Company Limited, of 39, Victoria Street Westminster, is introducing a system of electrical underground conduits hitherto unknown in this country; there are, however 157 miles of duct in operation at the present time in New York, Philadelphia, and other towns in America.



The Johnstone system of underground conduits consists of a cast iron box, composed of two troughs, one placed upon the other, a groove being cast on the edge of the lower trough, and a tongue on the edge of the upper one, so that when put together they exactly fit; these sections are 5 feet in length, excepting the first bottom section leading out of the man-hole, which is 2½ feet long, so as to break joints.

To ensure joints being water-tight, before the conduit is

laid, all grooves, recessed clamps, and abutting ends are filled with plumber's putty. The more it is immersed in water, the harder it becomes. Its entire reliability for making a tight joint has been ascertained by experience and careful observation in conduit structure.

The internal capacity of the conduit, which varies from 235 square inches to 4½ square inches, is divided into as many ducts, or compartments, as is desired, by means of an iron shelf 2½ feet long, with feet cast upon it, and is made to slide into grooves cast on the bottom section of the conduit; on the top of this shelf there are corresponding grooves to those on the bottom of the conduit section, and into these grooves a similar shelf, with feet, is placed, until the number to provide for the special number of ducts are pushed into position. This work is performed as the conduit sections are laid, and the top sections are placed in their position following the placing of the shelves.

The rapidity with which this system can be laid is a most favourable feature.

The illustrations are taken from work as actually done in New York.

An iron man-hole has been adopted as being very substantial and preventing the transmission of moisture. This man-hole, which can be of any size, is made in sections or rings of various widths, starting at the bottom with a solid iron pan, and by simply placing rings in succession one on the top of the other until the structure reaches the place at which the conduits lead into the man-hole. This ring is called the spigot ring, and is made in segments. In order to accommodate any size conduit these spigots are all of uniform size on the outer edges of the plate, and fit exactly into the ring, taking the place of one of the segments which has no outlet. Above this spigot ring is a hood or top made of sufficient strength to bear any street traffic, tapering to a proper size, opening at the street for the admission of a man.

In connection with electrical underground conduits there are three main points to which particular attention should be paid :—

1. Facility for distribution.
2. Accessibility.
3. The material used in construction.

1. The Johnstone system is especially convenient for distributing wires at any point in the circuit because of the sectional structure of the conduit, which enables a hand-hole

to be inserted at any time by removing a five-foot section, and replacing it by another one supplied with a hand-hole opening or distributing box.

In the course of laying the conduits a section with a hand-hole is placed in front of each building; these hand-holes consist of an opening large enough to give free access to the wires. The opening is covered with a removable plate, and when it is desired to make a connection with any house, this plate is removed, and a cover with spigot takes its place. This feature is very advantageous in street lighting, where it is often necessary to make connections at particular points which have not been provided for when the conduits were laid. It is equally easy to deliver the wires from the top or from the bottom section, and from the right or left side of the conduit, all the pieces being interchangeable.

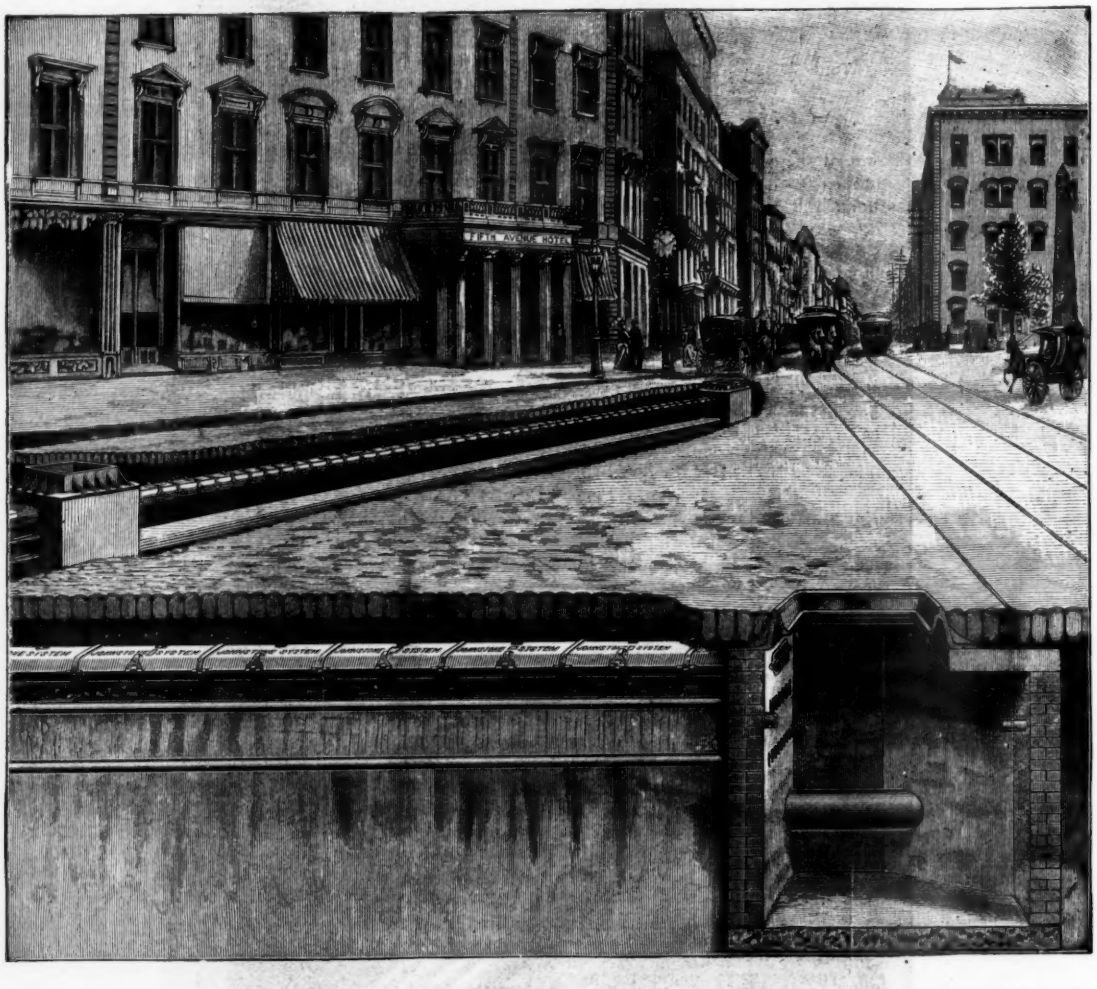
In making a joint at the hand-hole used in this system, provision is made for laying the necessary splices out of the direct line of the conduit which contains the cable, thus avoiding any danger to the splice, which naturally increases the size of the cable at that particular point. This device consists of a projecting casting attached at the time the connection with the house is made, and called a spigot. It extends outside the line of the structure, and prevents the possibility of any injury being done to the splice by a push rod for the purpose of drawing in other cables in the same duct.

The second feature in the Johnstone system is its accessibility.

As it is impossible to insulate wires with such perfection that defects will not occur at some time or other in a conduit carrying a high tension current, the question arises how to do the necessary repairs at the least cost, and with as little delay as possible. One of the great advantages of the 5-foot sections is that in the case of a defective wire, the exact position of which is known, the 5-foot top section is removed, if necessary all the partition shelves taken out, and the cables that are in use allowed to swing or suspend from their respective ducts over the place open, the cable can then be repaired. This operation disturbs *only* the defective cable, avoiding the laborious and expensive work of drawing the cable out from one man-hole to another. After the repair is made, the partition shelves can be slid into their original position, the cables adjusted in their ducts, and the top section replaced, making the conduit equal to its original condition.

In most devices for underground conduits, the only way a cable can be reached for repair after it has once been laid, is by removing bodily, or drawing out the damaged cable, the former necessitating the expense of digging up the street or pavement from man-hole to man-hole, or whatever the distance may be.

In considering the pipe system of conduits, the fact of screwing one pipe into a union joint, or any device used as the equivalent of a union joint, is almost certain to throw upon the inner surface of the pipe sharp edges which are liable to cut through, or at any rate damage, the insulation of the cable when it is being drawn in.



3.—The material used is cast iron. The sections are perfectly fitted together, so that each line of ducts forms a smooth uninterrupted casing, through which cables can be drawn without the possibility of injuring the insulation.

The Johnstone system is claimed as superior to an insulating or concrete system of conduits, because a metallic conduit facilitates the induced currents going to earth, whereas an insulating system produces dynamic induction, causing a disturbance in the operation of currents on all cables coming within the influence of such induction.

The conduits are manufactured in different sizes to meet the requirements of electrical services of various descriptions,

and in price they compare favourably with the methods now in use.

Type	A	A	has	24	ducts	with an area of	235	square inches.
"	A	"	"	16	"	"	150	"
"	A½	"	"	8	"	"	64	"
"	B	"	"	9	"	"	52	"
"	C	"	"	6	"	"	41	"
"	D	"	"	4	"	"	29	"
"	E	"	"	2	"	"	18	"

Types F and G are cylindrical cast iron pipes 3½ inches × 6 inches respectively in diameter; the pipes are cast in two equal longitudinal parts, they are grooved and fastened together with keys and wedges. They are in 5-foot sections, and furnish the same facilities for distribution and access as the larger types; like them they have a perfectly smooth inner surface.

The Johnstone system of electrical underground conduits thus composed provides for every requirement of electrical underground service in any desired quantity and of every description, viz.: Telegraph, telephone, electric light, electric power district messenger and fire alarm service, the cables and wires of which are at all times accessible at any point along the line of structure.

ELECTROLYTIC CAUSTIC AND BLEACH.*

By JAMES SWINBURNE.

The Anodes.

ALMOST every month there is a new scheme for making caustic soda and bleaching powder from common salt. The idea of electrolysing salt is very old, but it may have been neglected by capable men till recently on account of the cost of electrical power. Electrical power has now been producible at very low rates for several years, and still soda processes do not seem to get beyond the syndicate stage. Owing to the rapid improvement of electric machinery, electric power can now be supplied so cheaply that there is a large profit margin in making soda and bleaching powder electrolytically, so it is clear there is some other obstacle in the way. Each new inventor claims to have solved the difficulty, but on examination his process is generally found to differ from those that have gone before in unessential details, such as the arrangement of the anodes, or the use of this or that form of porous partition. Details like these can hardly make all the difference between failure and success, and it is probable that there is some other difficulty not generally known. This, I believe, lies in the anodes. Carbon is generally employed. There are several forms of carbon. Every form I have tried so far disintegrates quickly when used as anode in a solution which gives off oxygen. In the electrolysis of a chloride, carbon stands much better. Some years ago I thought it would stand permanently in a chloride solution, provided the current density were kept low, and that it might therefore do for bleaching. Further experiments in the same direction have been quite unsuccessful, and no form of carbon that I have tried will stand; it is gradually converted into a black mud.

It may be argued that such a difficulty as this cannot really exist, for it would be known to everybody who experimented on electrolysing salt. I can only say that carbon disintegrates very much more quickly in such solutions as the dilute sulphuric acid used in secondary batteries, and though people have been working at secondary batteries for more than ten years, carbon is still constantly proposed. The inventor of a soda process generally tries experiments on a comparatively small scale, and does not notice the corrosion of the anodes. If he does he probably says the carbon is impure, and there is no difficulty in getting a better material when he starts on a large scale. He therefore devotes his attention to improvements in the other parts of the process.

* *Industries.*

It may be urged that it does not matter if the carbon is destroyed, for it is cheap, and can, therefore, be easily replaced. This is, however, a matter of degree. Caustic and soda are made very slowly, even in a large vat, so a comparatively slow corrosion will add to the expense very largely. In addition to this, carbon in an atmosphere of chlorine is by no means easy to deal with, or to connect up electrically. Any crude form of carbon, such as retort deposits, takes up a great deal of room, and makes the vats very large for a given output, and this involves expense. Still all this is, of course, a matter of degree only. It may be urged that platinum anodes can be used. Platinum is very expensive, however, and the interest on the money would be serious. But, worse than this, platinum is itself slowly corroded. Professor Fitzgerald's invention of "lithanode" even, does not seem to present a solution of the difficulty; for free hydrochloric used reduces peroxide of lead, and there is always some liberated at the anode.

These remarks are not made with the intention of writing down any particular soda process. I have been several times consulted by inventors or purchasers of soda processes, and have always found the anode difficulty overlooked. It, therefore, seems best in the interest of progress to call attention to the probable weak point, so that inventors can devote their whole attention to it, before dealing with other and easier problems, such as the particular form of vat or partition.

MORE ABOUT ELECTROCULTURE.

THE January Bulletin of the Hatch Experiment Station, Amherst, Mass., U.S.A., contains an important *resumé* of the researches which have from time to time been undertaken in order to determine what effect electricity has upon the economy of plant life, and whether it is capable of being applied advantageously in the operations of horticulture and agriculture. With most of these researches, our readers who take an interest in what has, for want of a better term, been rather vaguely styled "Electroculture," are more or less familiar; but even they may find it useful to know where they may consult the history, such as it is, of this curious and possibly useful application of electricity. They will find all they want carefully collected by Mr. Clarence D. Walker, in the Bulletin referred to, and a perusal of the data therein recorded will be sufficient to convince anyone that there is more in electroculture than may at first sight appear.

Undoubtedly it has been established that electricity under certain conditions does exercise a beneficial action upon the growth of vegetation; and the fact that such minds as those of Sir Humphrey Davy, Humboldt, Wollaston, Becquerel, Williamson, Hubeck, Von Ende, Fischer, &c., and more recently of Specnew, Grandeau, Macagno, &c., having been attracted to the investigation of it, is a guarantee that it is not beneath the notice of those of our modern electricians who are anxious to strike out a new line. There are (in this case literally speaking) vast fields of research which need tilling and cultivating, or at least exploring, and at present only a few have turned their active attention to it, so that no one need be afraid of entering upon work in which he may be jostled by others.

We have not hitherto noticed the experiments in electroculture, which have been in progress under the auspices of the United States Department of Agriculture, or at least if we have, our notice has been but brief. Hence the following abstract from the recently issued Bulletin may not be without interest to our readers, especially as more details are available than are usually forthcoming concerning the *modus operandi* of the investigation undertaken.

The following experiments will serve to illustrate the lines upon which the researches were carried on:—Several plots were prepared in a greenhouse, all of which had the same kind of soil, and were subjected to like influences and conditions. Frames, about three feet by two feet, were put together; across the narrow way were run copper wires in series of from four to nine strands, each series separated by a space about four inches wide, and the strands by a space of one-half an inch. These frames were buried in the the soil

of the plot at a little depth, so that the roots of the garden plants set therein would come in contact with the wires, the supposition being that the currents of electricity passing along the wires would decompose into its constituents any plant food in the vicinity of the roots, and more readily prepare it for the plants. The electric gardens thus prepared were each furnished with two common battery cells, so arranged as to allow continuous currents to pass through each series of wires. Near each electric garden was a plot prepared in the same manner, save the electrical apparatus.

The place chosen for the experiments was in a part of a greenhouse devoted to the raising of lettuce, and the gardens were located where much trouble from mildew had been experienced. The reason for this choice of location was to notice the effect, if any, of electricity upon mildew, this disease being, as is well known, a source of much trouble to those who desire to grow early lettuce. The soil was carefully prepared, the material being loam. We will call the two "electric gardens" A and B. Garden A was located where mildew had been the most detrimental. The experiments began January 1st and closed April 1st. For this garden, fifteen lettuce plants of the "head" variety were selected, all of the same size and of the same degree of vitality, as nearly as could be determined; the plants were set directly over the wires, so that the roots were in contact with the latter; they were well watered and cared for as in ordinary culture, and the fluid in the battery cells was renewed from time to time, that the current of electricity might not become too feeble.

At the close of the experimental period the following results were noted:—

Five plants died from mildew, the others were well deveveloped and the heads large. The largest heads were over the greatest number of wires and nearest the electrodes. It was further noticed that the healthiest and largest plants, as soon as the current became feeble or ceased altogether, began to be affected with mildew. On examining the roots of the plants it was found that they had grown about the wires, as if there they found the greatest amount of nourishment; the roots were healthy and in no way appeared to have been injured, but, rather, much benefited by the electrical influences.

Beside garden A was prepared another plot of the same dimensions, having the same kind of soil; this was treated in like manner as the first, but the electrical apparatus and wires were wanting. At the close of the experiments only three plants had partially developed, and two of these were nearly destroyed by mildew—one only was free from the disease. The results, therefore, show that the healthiest and largest plants grew in the electric plot.

In the second series of experiments a plot, B, was prepared and in it were placed twenty plants of the same variety of lettuce and of equal size and vitality with those in plot A, whilst the treatment also was the same. Five plants only remained unaffected with mildew; seven died from the disease when they were half grown; the rest were quite well developed, but towards the end of the experiment began to be affected. Several heads were large, the largest being over the greatest number of wires and nearest the electrodes. Examination of the roots disclosed the same phenomena as in plot A.

Near plot B were also set twenty other plants, subjected to similar conditions as the first, but without electricity; all but one died from mildew before they were half grown, the solitary plant that survived being only partly developed at the close of the experiment, and even this was badly affected with the disease.

Everything considered, the results were in favour of electricity. Those plants subjected to the greatest electrical influence were hardier, healthier, larger, had a better colour, and were much less affected by mildew than the others.

The question naturally arises whether there may not be a limit reached where electricity would completely overcome the attack of mildew and stimulate the plant to a healthy and vigorous condition throughout its entire growth.

From the fact that the hardiest, healthiest, and largest heads of lettuce grew over the greatest number of currents and nearest the electrodes, those responsible for the report in the Bulletin seem inclined to argue that electricity is one of the agents employed by nature to aid in supplying the plant with nourishment and to stimulate its growth. We have heard this theory before, and it requires proving or disproving.

To what extent plants may be submitted to electrical influence, or what strength of current is best suited to them and what currents prove detrimental to their development, have not been determined as yet, and it is desirable to continue these researches until some definite information shall be gained on these points. Probably different varieties of plants differ greatly in their capacity for enduring the action of electric currents without injury—experiment alone must determine this. Meanwhile we exhort our own State Department of Agriculture not to be behind America. Surely in this country the interests of the farmer and the horticulturist are not in such a flourishing condition that we can afford to ignore a possible means of improving them. Encouraging results have been obtained in France, Germany, Italy, the United States, and even in Russia. Is it not time that a little more activity in this direction were exhibited nearer home?

NEW MODE OF EMPLOYMENT OF CONTINUOUS CURRENT TRANSFORMERS.

CENTRAL electric lighting stations can only economically supply a certain area, of which they form the centre. The lower the electromotive force that is employed, the more limited this area is, and it would often be desirable to exceed these limits in order to reach groups of lamps beyond them. To do this various methods may be employed.

We will suppose, for instance, that we have a central station working at 110 volts; this station is capable of working lamps within a radius of from 600 to 700 metres; in order to exceed these limits we must employ at the central station machines of higher tension, either continuous or alternating current, and this higher tension must be brought back to 110 volts by means of transformers at the place where it is to be consumed. Alternating currents entail the inconvenience of introducing into a system working with continuous current machines at 110 volts, machines working on quite a different system, which cannot be substituted for the first; thus the installation becomes complicated, and we are prevented from having recourse to accumulators.

Moreover, we cannot connect together the two systems of distribution at low tension, since one is a continuous current and the other an alternating current system. It will, therefore, be preferable to employ continuous current; unfortunately continuous current transformers are dear, and their efficiency seldom exceeds 80 to 85 per cent.

There is, however, a method, says Mr. Rechniewski in *l'Industrie Electrique*, which enables us to reduce by one-half the price of purchase and the total losses, and it is this that we are now going to describe.

We will take a simple case, and one which often occurs in practice, a central station working at 110 volts. As we have already shown, it can only be used economically for lighting within a radius of from 600 to 700 metres. We will suppose that we have to supply a group of 1,000 lamps, placed at 1,800 metres from the works; 1,000 lamps of 10 candles at 40 watts, make 40 kilowatts (110 volts, 360 amperes).

We may feed this group of lamps either by means of a feeder, in which we make up our minds to lose 20 or 30 per cent. of the energy transmitted, and which, by reason of its great section and its length is very expensive; or by means of continuous current transformers, for which the following arrangement will be the most economical; we will connect at the central station, in series with the battery of machines of 110 volts already in use, a similar machine, from which we get 130 or 140 volts; thus we shall have at the works from 240 to 250 volts. We will send the electricity under this voltage to feed the group of lamps to which the current is to be supplied. By employing this higher voltage, we can reduce by one-half the weight of cable employed, and at the same time lose only from 10 to 15 per cent.

At the point of arrival, then, we shall have about 230 volts, deducting the loss along the line; we shall then direct the current into a transformer which transforms only from 120 to 110 volts; there will therefore remain 230 — 120 = 110 available volts after the current has passed through the

transformer. This is the voltage required by the lamps. But the secondary of the transformer also supplies us with current at 110 volts ; we can, therefore, employ it in quantity with the current that is at our disposal on leaving the transformer (see fig. 1).

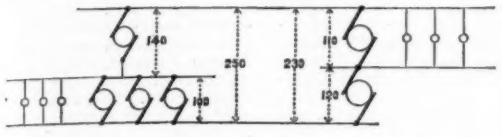


FIG. 1.—EMPLOYMENT ON A DISTRIBUTION BY TWO WIRES.

In fact, the transformer has, so to say, served to reduce the voltage of one part of the current to the voltage of the other, and to place in quantity what was before in series. We shall thus transform only half the electrical energy ; the expense of the transformer is therefore only half what it would be if we had transformed the whole, and the loss which is inevitable in all transformations only affects half the energy supplied ; it is consequently only half as great.

Moreover, at the central station this method does not necessitate the employment of machines of a different type from those already installed.

It can also be applied when a feeder proves insufficient ; instead of substituting a larger one for it, we can double the voltage, and consequently the power transmitted by the cable.

At the arrival station, the regulation of the voltage at the terminals of the lamps is automatic, *i.e.*, the transformer cannot alter, and as long as 230 volts are maintained with the two conductors at the arrival station, we shall get 110 volts for the lamps, whatever may be the load, and however sudden may be its variations.

In fact, when no lamp is alight, the two primary and secondary armatures are placed in series and both act as motors, so as to create a counter-electromotive force of 230 volts (the inductors being excited in derivation).

When the lamps are lighted, the current in the secondary changes, and this latter begins to supply current concurrently with the direct circuit.

It is evident that, instead of doubling the electromotive force, it might be trebled or quadrupled by the same method, but the benefit derived from it would not be so important.

This method may also be applied to distributions by three, four or five wires ; fig. 2 shows its application to the system

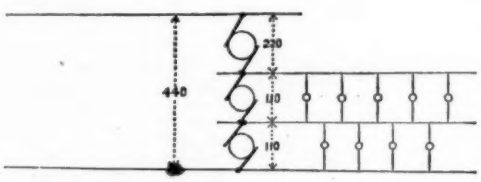


FIG. 2.—EMPLOYMENT ON A DISTRIBUTION BY THREE WIRES.

with three wires. The energy may be sent to the place where it is to be consumed under a tension of 440 volts, for instance, by means of two conductors ; the current is first made to pass into a transformer, the primary of which absorbs 220 volts, and which possesses two distinct secondaries, each capable of supplying 110 volts. The two secondaries supply the system of three wires as two ordinary generators would do, with this difference, that the primary current issuing from the primary armature enters into the system by one of the extreme conductors to leave it by the other.

In this case, the two secondary circuits play a double part ; in the first place, they act as two generators moved by the primary armature and supply current to the lamps ; they afterwards act as compensators and equalise the potentials between the three wires in a similar manner to the compensators utilised by the sector of the Place Clichy.

We will now consider the question from an economic point of view ; we will take our example again, and consider in the first place the direct supply at 110 volts by means of a feeder, in which we lose 20 per cent. of the power transmitted.

To feed 1,000 lamps of 10 candles at a distance of 1,800 metres from the works, and at 110 volts, we require 363 ampères.

Assuming 30 per cent. of loss in the conductor, we shall get a section of 790 square millimetres, corresponding to a weight of copper of 25,200 kilogrammes.

By employing the method described, we can work at a double voltage ; to compare the figures, we assume the same total loss, *i.e.*, 20 per cent., or 10 per cent. only in the line, and 10 per cent. in the transformer.

Under these conditions, the line will only weigh half as much, viz., 12,600 kilogrammes, but we require, in addition, a transformer capable of transforming 20,000 watts from one voltage to the other. The cost of this transformer will certainly not exceed 6,000 francs, whereas the cost of the 12,600 kilogrammes of conductor which we had in the first case, will certainly exceed, including laying and insulation, 40,000 francs.

The difference, as we see, may be sufficiently great to justify the employment of the method we describe.

THE COMPARATIVE COST OF GAS AND ELECTRICITY.

THAT recent *quasi*-technical production, whose flashes generally indicate that thunder is not far off, has thought fit to attempt to criticise our article on the comparative cost of electricity and gas which appeared in the REVIEW for February 5th. Probably by this time our newly fledged contemporary heartily wishes it had left the matter alone, for, by a combination of fortuitous circumstances, its critical article, read in combination with the weekly letter of Chesterfield Junior, in the same issue, completely vindicates the position we thought fit to adopt.

About half a column of *Lightning* is devoted to considering for what class of readers the leaderettes in the REVIEW are written ; but so far as those under discussion are concerned, it was plainly enough hinted that the data there given—not scientific, but commercial figures—was for the benefit of those who would so warmly welcome the guidance of the gentleman who is getting some little notoriety for knowledge (?) of electrical subjects. Our contemporary says :—

> Chesterfield Junior, it will be noticed, stated the proper proportion to be as one is to eight, whereas the ELECTRICAL REVIEW states that the proper proportion is as one is to 12, electrical energy at 5d., 6d. or 8d. per Board of Trade unit being equivalent to 5s., 6s. or 8s. per 1,000 cubic feet for gas, and that in consequence "would-be users of the electric light, to whom money is an object, must decidedly put on their considering caps for a while at all events."
>
> As an ounce of practice is worth a ton of theory, we appeal with confidence to the experience of the users of the electric light in London as to whether their electric light bill for 1891, made up on the basis of, say, 8d. per unit, was almost exactly three times as heavy as their gas bill for 1890, made up on the basis of 2s. 9d. per 1,000 cubic feet, as it should be if the ELECTRICAL REVIEW's contention be true, that 8d. for electricity is equivalent to 8s. for gas.
>
> We reprint in this connection a letter from a consumer, whom we know to be neither a gas nor an electric light shareholder, with the full confidence that his experience is very much the same as that of others who have the electric light supplied to them from a central station. He says :—
>
> "I think you would like me to give you an estimate of the cost of the electric light as against gas at my house. I have always put it down in my own mind that the cost of gas being 100, the electric light would be 150, but I felt *that* was quite the outside ; well I've gone carefully over my gas bills of 1887 and 1888. When I had gas only they amount to £64.
>
> "1889 and 1890 show the gas and electric light accounts as totalling £96 (we 'came into' electricity early in 1889, above the kitchen floors ; we have still gas in the kitchens). These figures bear out my idea, but it must be remembered that practically in those years we had no gas in the drawing room, which is a large one lighted now with 10 lamps of 16 C.P. (and others in the boudoir). We used to use oil lamps and candles, therefore I think a fair estimate of

matters is that the light is 25 per cent. dearer than gas; but this is certainly only nominal, the comforts of having it are untold, and the saving to furniture and decorations must be so great as to reduce to *nil* any excess of cost, which apparently exists."

We should like the ELECTRICAL REVIEW to point out to us how it is in this case that electricity apparently only costs 25 per cent. more than gas, or equal to 3s. 5d. per 1,000 cubic feet for gas, when, according to their theory, it ought to be equivalent to gas at 8s. Does the ELECTRICAL REVIEW seriously think that the users of the electric light throughout the metropolis are actually paying for it from two and a-half to three times as much as they formerly did for gas? If so, we think its editor must be unique in his opinion.

The editor of *Lightning* must be painfully aware how untenable is the position he has taken up, or why should he adopt such meaningless arguments as those contained in the above letter? The electric light bill may be anything. The writer gives no particulars of the hours of lighting with incandescent lamps as compared with his former gas burners; indeed, the whole matter is, as the letter clearly defines, one of surmise only, except that it shows that the actual sum paid for gas and electricity combined was more than for gas alone, or, that while in former days he was wasteful of his gas, he now takes good care to switch off the electric lamps each time the rooms are left unoccupied even for a few minutes. The proportion of electric light hours to gas hours is so completely ignored that it is useless to comment further upon a letter so pointless. Therefore the ELECTRICAL REVIEW still seriously thinks as it did before on the light for light basis, and the editor is not alone in his opinion. The parallel columns are so self-explanatory that we only need remark that Mr. Preece will doubtless feel highly honoured by the staunch advocacy of his statements on the one hand, and the doubts cast upon his experiments on the other, in the same issue of the same journal. With Mr. Dibdin, the Chemist to the London County Council, to support our contention that a flat flame burner consuming 5 feet of gas per hour produces 15 candle-power, and Mr. Yeaman's assertion that he knows 11,500 street burners giving this efficiency, it now only remains for *Lightning* to gracefully acknowledge the error into which it has fallen.

When the discussion of the subject was started a fortnight ago in one of Chesterfield Junior's letters to his Father, it was therein stated that Mr. Preece concluded at the G.P.O. some time since that in an ordinary burner one foot of gas will, during an hour, yield a two-candle light or even less.

Now, throughout the electrical industry any experiments which are published on the authority of Mr. Preece, the chief electrician of the Post Office, are treated with great respect; and, according to our hypothesis, only by those for whom the leaders and leaderettes of the ELECTRICAL REVIEW are written will the sneer at Mr. Preece be appreciated, viz., that "the conclusion of Mr. Preece that his P.O. burners gave about 2 candle-power or less per cubic foot of gas, was at best only a surmise on his part, for we have failed to ascertain that any actual tests were made; but even if true, it simply shows that through long continued use, or some other cause, these burners were not doing their duty." It is, indeed, surprising to find such a piece of impertinence in any journal devoting itself to the electrical business.—*Lightning*, February 11th, p. 368.

Perhaps the best thing we can do is to appeal from the ELECTRICAL REVIEW of last week to the ELECTRICAL REVIEW of July 3rd last:—

"Mr. W. H. Preece, F.R.S., M.I.C.E., electrician of the General Post Office, addressed the members of the Incorporated Association of Municipal and County Engineers at the Institution of Civil Engineers, Great George Street, Westminster, on Friday, on the 'Relative Merit and Cost of Gas and Electricity for Lighting Purposes.' . . . . However proud we, as gas engineers, may be of producing gas of 20 candle-power, when you come to the houses and shops of users and consumers you find this 20 candle-power is very considerably diminished. This is a very important question, and one which some six or seven years ago concerned us in the Post Office very much, and Mr. Vernon Harcourt, F.R.S., and I, devoted considerable time to experiments on this question. Mr. Vernon Harcourt, who is a very painstaking, careful and accurate experimenter, found that the ordinary gas burner, *supposed to be consuming 5 feet per hour and giving 16 candle-power* in London, really gives only 10 candles, due partly to dirt in the burner, but principally to the flickering of the light of the gas caused by draughts of air in the room. Dr. John Hopkinson, F.R.S., has also found that one cubic foot of London gas only gives 1·9 candles for an hour. So while a light burning in a special burner in a laboratory may give 16 candle-power, when you come to a room or passage that lamp will only give 10 candles. This *pro rata* value is equally true of Manchester as of elsewhere."

With regard to the real question between me and Mr. Yeaman, whether 4d., 8d., and 1s. for electricity compares with 4s., 8s., and 12s. for gas, as urged by him, or, with 2s. 8d., 5s. 4d., and 8s., I venture to refer Mr. Yeaman to an article upon the subject which appears in this week's issue.

Of course, the whole thing turns upon the question whether five feet of gas per hour in an ordinary burner really yields a 15-candle light during the hour, or a 10-candle light as determined by the experiments of Mr. Preece.— *Lightning*, February 11th, p. 377. Letter of Philip Stanhope to his father.

In referring to Mr. Preece's lecture delivered last year before the members of the Incorporated Association of Municipal and County Engineers, entitled, "Relative Merit and Cost of Gas and Electricity for Lighting Purposes," we find the following passage: "However proud we, as gas engineers, may be of producing gas of 20 candle-power, when you come to the houses and shops of users and consumers you find this 20 candle-power is very considerably diminished. This is a very important question, and one which some six or seven years ago concerned us in the Post Office very much, and Mr. Vernon Harcourt, F.R.S., and I, devoted considerable time to experiments on this question. Mr. Vernon Harcourt, who is a very painstaking, careful and accurate experimenter, found that the ordinary gas burner, *supposed to be consuming 5 feet per hour and giving 16 candle-power* in London, really gives only 10 candles, due partly to dirt in the burner, but principally to the flickering of the light of the gas caused by draughts of air in the room." It seems a pity that Mr. Harcourt did not actually ascertain what quantity of gas was passing through the burners, for, as we pointed out last week, and as this quotation shows, they were evidently not doing their duty, and *perhaps* consuming only four feet of gas per hour instead of five, and we regret to observe that in Wednesday's *Daily Graphic* Mr. Preece, notwithstanding the assurance which the chemist to the London County Council gave us last week, that a good flat flame burner gives a duty of three candle-power per cubic foot of gas consumed, repeats this statement. —ELECTRICAL REVIEW, Feb. 12th.

Now we may give a friendly hint to the editor of the ELECTRICAL REVIEW that it would be very wise on his part if he insisted upon the perusal by the comic man, who writes his leaders and leaderettes and jokes at "*Lightning*," to read a few of the back numbers of his own REVIEW, so that he may not bring his journalistic brethren into contempt by stating he has "failed to ascertain that any actual tests were made," when those very tests were solemnly reported in his own pages six months before.— *Lightning*, February 11th, p. 368.

On the general question we repeat that the ELECTRICAL REVIEW's contention that the proportion between the cost of electricity (per unit) and that of gas per thousand feet is as one is to 12 is quite untenable.

According to the careful experiments referred to by Mr. Preece:—

10 candles light given by gas for one hour = 5 feet of gas.

2,000 candles light given by gas for one hour = 1,000 feet of gas.

250 candles light given by electricity for one hour = one Board of Trade unit; and

2,000 candles light given by electricity for one hour = eight Board of Trade units;

therefore,

1,000 feet of gas = eight Board of Trade units; and 5s. 4d. per 1,000 feet gas = 8d. per unit for electricity,

or, in other words,

If, instead of using the ELECTRICAL REVIEW's multiple of 12, we multiply the cost per

To the editor of *Lightning*.

Dear Sir,—With regard to Chesterfield Junior's remarks upon my last letter *re* cost of Liverpool electric lighting, I have to beg your permission to answer the queries put to me by that gentleman.

Gas in Liverpool costs to-day 3s. per thousand cubic feet; electricity for all *private* consumers (in contra-distinction to shops and other places of public resort, which burn all their lamps more than 400 hours per annum) costs 1s. per unit, with 30s. a year for meter rent.

According to the tests I took last winter in the corporation laboratory, the Ediswan lamps used on the Liverpool circuits, with a difference of potential of 110 volts on their terminals, take when new 3·75 watts per candle, going up to 4·25 watts as their life is spent.

That is to say new lamps give

$$\frac{1,000}{3\,75} \text{ or } 266\tfrac{2}{3} \text{ candle hours per unit.}$$

The average is the usually accepted figure of 250 candle hours per unit, thus:—

unit of electricity by eight, we arrive roughly at the equivalent cost of gas per 1,000 feet for the same illumination.—*Lightning*, February 11th, p. 369.

266⅔	250 candle hours per unit
12	12
3,200	3,000 candle hours for 1s. × 12.

Gas as used in burners, taking 5 cubic feet per hour, gives 16 C.P. (and I know of 11.500 burners giving this efficiency, *i.e.*, the street lamps), that is to say—

16
200

3,200 candle hours per 1,000 cubic feet of gas at 3s.

So that *new* incandescent lamps give light for light with Liverpool gas with an expense of four times that which would be incurred for gas. The ratio is worse for electricity taking the average. I happen to have by me a table, issued, I believe, by the *Electrical Engineer*, at the beginning of 1889, and I see from it that "Electricity *v.* Gas" stands with 1s. per unit, and efficiency of lamps 3½ watts per C.P.; 12s. per 1,000 cubic feet of gas. It is there stated that four watts brings the figure up to 12s. 9·6d. It therefore seems that Chesterfield Junior has nothing to prove a fallacy upon in my remarks to you recently, and I can assure you that 1s. per unit is the average price from inspection of many consumers' bills. And yet the company say that electricity costs about twice gas.

As a friend to electric lighting these facts should be stated plainly, and much more satisfaction will result than from any other course which is detrimental to the industry from the false hopes raised by such specious promises.—Believe me, faithfully yours,

CHARLES H. YEAMAN,
Late City Electrical Engineer,
Liverpool.

—*Lightning*, February 11th.

LONDON COUNTY COUNCIL.

THE following report of the Parliamentary Committee was submitted:—

Railway and other schemes, 1892.—*Underground Communication.*

We have had under consideration the 14 railway schemes, three tramway schemes, and six miscellaneous schemes, ten electric lighting schemes, and three telephone schemes of the ensuing session, affecting the County of London, and the usual report of the engineer thereon, a copy of which has been forwarded to each member of the council. We have also received a valuable report from the agent, a considerable portion of which we have adopted as the basis of this report. We are not prepared to report on the whole of the schemes at present, but we submit our recommendations with regard to the majority.

Of the private bills introduced into Parliament, there are 33 which appeared to the agent to require investigation as affecting or possibly affecting the interests of the county.

The Bills may be classified under three heads:—(1) Railways; (2) tramways; (3) miscellaneous.

Several of the bills involve questions of the highest importance to London, the railway schemes especially forming a group more numerous and important than those of any recent session of Parliament. They include the proposed new trunk line of railway from the North into London with its terminal station, as proposed by the Manchester, Sheffield and Lincolnshire Railway Company, in addition to several schemes for railways into and through the centre of London.

We do not consider it necessary in this report to give detailed descriptions of the works proposed by the various bills, full particulars of which will be found in the engineer's report. This report is mainly directed to more general questions which have to be considered by the council in determining the course to be pursued in regard to the several bills.

Some discussion has taken place in recent sessions as to how far buildings connected with railways in London ought to be subject to the provisions of the Metropolitan Building Act. The provisions of that Act apply generally to all buildings in London with certain specified exceptions, one of the exceptions being "the buildings belonging to . . . . . any railway company, and used for the purposes of such . . . . . railway, under the provisions of any Act of Parliament." The effect of this enactment appears to be that any building erected by a railway company on land within the County of London would be exempt from the provisions of the Building Act, unless otherwise provided by the special act authorising the acquisition of the land. The question now becomes of somewhat special importance in connection with the proposed works of the new underground railway companies, who may have a station with platforms, &c., underground, and buildings over them which may form part of the buildings in an ordinary street, and be adjoined on both sides by buildings subject to the Building Act. While the railway companies object strongly to the application of the Building Act to their stations and platforms, the exemption of an ordinary building in the line of the street, merely because it is on land acquired by a railway company, seems to involve a certain anomaly. It will be necessary, owing to a recent legal decision, to insert in several of the railway bills a clause prohibiting the companies from bringing forward their buildings beyond the general line of frontage of buildings in streets, it having been decided that under a special act authorising a railway company to construct works, their buildings may be placed on any part of the land delineated on the deposited plans, although it may be in front of the general line of building in the street.

We think that the attention of the council ought to be specially directed to the London railway schemes of the session, which are more numerous and far more important than any group of railway bills affecting London introduced in any session of recent years. It seems to us that the general policy of these bills, their route and method of construction, demand close consideration by the Council, as well as the matters of greater detail in regard to the protection of sewers and streets, assuming that the lines or any of them are favoured by the council. When the Central London Railway Bill of last session was under consideration, a very elaborate code of clauses was prepared by the Parliamentary Committee of the council, for the protection of the streets, main sewers, and other matters in which the council are more directly concerned, and these clauses were ultimately adopted by Parliament and contained in the Central London Railway Act. The provisions of these clauses appear capable of general adaptation, and to be practically sufficient, except in regard to special cases, to secure the interests which the council has to protect in reference to these underground railway schemes. It appears from the sections and the engineer's report that the lines generally are to be constructed at such a depth below the surface that there is no great risk of injury (if proper clauses are inserted) to the main sewers. This suggests the consideration of whether in cases of this kind it is desirable that the line of street should be followed as in the present bill, or that a shorter and more direct route should be sought by carrying the tunnel partly under houses.

The Baker Street and Waterloo Railway, for instance, is projected to occupy the subsoil for the most part under the public streets, the reason being, no doubt, that under the present system the promoters cannot be called upon to make any considerable payments by way of purchase money for the right to occupy the subsoil under the streets. But the result, probably, is a more circuitous and unsatisfactory line with greater cost of construction than might be obtained if the promoters were empowered to tunnel under houses on payment of proper compensation for damage which they might cause. The scheme in question appears to consist of the formation of two tunnels of 12 feet internal diameter, and if a north and south railway through the centre of London is now to be definitely authorised, the council may wish to consider carefully, in the general interests of London, whether the scheme as now proposed is the best that can be devised, or whether any other route or system would be preferable. Of course, the authorisation of either this or the Hampstead and Charing Cross scheme will practically settle the question of cross-London railway communication, and it may be thought desirable that Parliament should be asked to refer these and the other London railway schemes of the present session to a joint committee, or to a special select committee, with power to enquire thoroughly into the question of the future railways of central London.

All the other underground schemes seem to fall within the same category. In some of them, however, additional protective clauses ought to be introduced, and whatever policy the council may follow with regard to them on general principles, they will all require to be carefully watched, and petitions should be presented against them, to entitle the council to be heard before the Committee.

We recommend (*a*) That petitions be presented against the Baker Street and Waterloo Railway Bill, the Central London Railway Bill, the City and South London Railway Bill, the Great Northern and City Railway Bill, the Hampstead, St. Pancras and Charing Cross Railway Bill, and the Waterloo and City Railway Bill, with a view to securing the insertion of clauses prohibiting the companies from bringing forward their buildings beyond the general line of frontage of buildings in streets; and also to obtain sewer, bridges, placard, or other necessary clauses, as specified in the table given at page 8 of the Engineer's report.

We further recommend (*b*) that Parliament be asked to refer the underground railway schemes of the present session to a joint committee or to a special select committee, with power to inquire thoroughly into the question of the future railways of Central London. (*c*) And that it be referred to the Building Act Committee to consider and report forthwith as to what additional provisions should be recommended to Government for insertion in the London Building Law (Consolidation) Bill in connection with new railway stations and buildings, and alterations by way of additions to existing railway stations within the County of London.

Ward Electrical Car Company.

The object of this Bill is to authorise the Ward Electrical Car Company, by agreement with local authorities, to use electrical carriages, and on being licensed, to ply for hire with them. This is the first application for licensing for hire electrical power, and, with the concurrence of the Highways Committee, we consider that

the present opportunity should be taken for making the Council the licensing authority for the user of the cars, and that the same should not be left to the Home Office. As the Bill is at present framed, nothing can be done without the consent of the local authority. The Bill will make the Corporation the local authority as regards the City of London, and the council the authority as regards the rest of the Administrative County of London.

We think that the council's *locus standi* with regard to the Bill should be maintained, and that the Bill should be amended so as to make the council the licensing authority for plying for hire, and we recommend that a petition be presented against the Ward Electrical Car Company's Bill.

Lambeth Electric Supply Order, 1890.

We reported on December 23rd last that the Board of Trade proposed, subject to any observations which the council might wish to offer, to revoke this order, the undertakers having failed to satisfy the department of their ability to discharge the duties or to make the deposit required by section 7 of the order; and the council, on our recommendation, decided to offer no observations, and to leave the matter to be determined by the Board. We have now to report that formal notice of the revocation of the order has been received from the Board of Trade.

Notices under Electric Lighting Acts and Orders.

We have considered a notice, dated January 27th, 1892, from the London Electric Supply Corporation, of intention to lay distributing mains, consisting of concentric lead-covered cables drawn into cast-iron pipes, in Charles Street, Berkeley Square, and Chesterfield Street. Similar works have been approved by the council on previous notices of this company; and we recommend that the sanction of the council be given to the works referred to in the notice dated January 27th, 1892, of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains be laid under the footways, and be kept 9 inches below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material, as the case may be; that the positions of the street-boxes, and the mode of construction of them, shall be submitted to and approved by the council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering.

We have also to report the receipt of the undermentioned notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid: From the London Electric Supply Corporation, January 29th, 1892—to 62, Charing Cross; 25, Charles Street, Berkeley Square; 3rd February, 1892—to 31 and 54, Borough High Street; 3, Duke Street, Tooley Street; 149 and 215, Westminster Bridge Road. From the St. James and Pall Mall Electric Lighting Company, February 1st, 1892, to 208, Regent Street; 21, St. James's Street.

PARLIAMENTARY NOTES.

St. Catherine's Lighthouse and the "Eider."

In the House of Commons on February 12th, Mr. Lea asked the President of the Board of Trade whether it was correct that the officers in the *Eider*, recently wrecked on the Isle of Wight coast, were unable to see the light of St. Catherine's lighthouse; whether the electric light of St. Catherine's Point was less effective in fog than the Wigham triform group flashing gas light of Tory Island, off the north-west coast of Ireland; whether he would consider the advisability of supplementing the electric light at St. Catherine's by the vertical sky flashing light recommended by the Shipmasters Society of London, and others, and whether, meanwhile, the experiment for producing thrills in fog, recommended by Prof. Tyndall in his letter to the *Times* on the 3rd inst., would be tried at St. Catherine's?

Sir Michael Hicks-Beach: In the deposition made before the Receiver of Wreck by the master of the *Eider*, no mention is made of the light at St. Catherine's having been seen by the officers of the ship which struck on Atherfield Ledge in a thick fog, about 3½ miles from the lighthouse. Upon the second and third paragraphs of the hon. member's question, I have been in communication with the Trinity House, who state that whether the Wigham light at Tory Island is more effective in fog can only be estimated from the results of experiments at South Foreland (Parliamentary Paper, C. 4,551, 1885), which were conclusively in favour of the electric light. Experiments in sky flashing, so far as they have gone, have not been encouraging for the adoption of that system, and the Elder Brethren are in communication with the Shipmasters Society on the subject. Prof. Tyndall's letter of February 3rd was written under a misapprehension. Very powerful and perfect thrills in fog are sent from the illuminating apparatus at St. Catherine's, a sudden flash of over 6,000,000 initial candle-power being given for five seconds, followed by an equally sudden eclipse of 25 seconds

Electric and Cable Railway Schemes.

Mr. Whitmore has given notice of his intention to move: "That a Joint Committee of Lords and Commons be appointed to consider the best method of dealing with the electric and cable railway schemes proposed to be sanctioned within the limits of the metropolis by Bills introduced, or to be introduced, in the present session, and to report their opinion as to whether underground railways worked by electricity or cable traction are calculated to afford sufficient accommodation for the present and probable future traffic; as to whether any, and which, of the schemes propose satisfactory lines of route; as to the terms and conditions under which the subsoil should be appropriated; whether any, and, if any, what, schemes should be proceeded with during the present session. That a message be sent to the Lords to communicate this resolution, and desire their concurrence."

MR. LIVESEY AND THE ELECTRIC LIGHT.

Mr. G. Livesey, presiding on Wednesday at the half-yearly meeting of the shareholders of the South Metropolitan Gas Company, at the Bridge House Hotel, was asked several questions respecting the progress and cost of the electric light.

Mr. Foster said that he had been going about the City lately, and had noticed a great deal of work being done in connection with the electric light. He would like to know if the chairman could tell if gas for the half-year cost, including repairs, £50, what he would have to pay for an equal amount of light out of electricity, calculating in the last mentioned the interest on electrical fittings, and the keeping of them in order. Perhaps the chairman might be able to say something which would convince them that they had not much to fear from electricity, at least in the district which the company served.

Mr. Field thought it would be interesting to know also whether there was any electrical plant being laid down in the South Metropolitan district. Of course there was no question whatever that the electric lighting companies were making great strides, and they were exerting themselves to the utmost to extinguish the gas undertakings. The success of the gas companies was attributable to the cheapness with which they could supply the gas, and he hoped the directors would soon be able to bring back the price to the old price of 2s. 6d.

The Chairman: 2s. 3d.

Mr. Field contended that electricity had done the gas companies a great deal of good, for it had driven the people to demand a much better light.

The Chairman, in reply, said that as to the electric light, Prof. Forbes had stated at the Society of Arts that it was all nonsense to say that the electric light was as cheap as gas. The Chairman believed the Professor said that it was not fair to delude the people in that way, and he added that the electric light at 7d. per unit was about equivalent to gas at 7s. a 1000, or, at any rate, it was, he said, equivalent to more than double the price of gas. But other estimates had put it at three times the cost of gas. So that the gentleman who paid £50 a year for gas if he desired to get an equivalent in electric light would, at the lowest estimate, have to pay more than £100; but he (Mr. Livesey) believed that it would cost him £150, or three times that of gas. The price charged was their safeguard. The South of London was a rather poor district, and the people were not likely to pay £2 for that which they could get for £1. As to the question of whether any electrical plant was being erected in the South of London, the Chairman said there were a few private installations in gentlemen's houses here and there. There was one at Brixton, and there was a large electric lighting plant at Deptford for the supplying of the City and the West End. The conductors were put on the side of the South Eastern Railway; but that he did not think was working very successfully. At any rate they did not hear much about it.

REVIEW.

Universal Office Manual. By Oxborrow and Money-Kent. London: The Authors, 17, Victoria Street, S.W.

This very useful and interesting treatise on counting-house and business routine begins with an explanation of what is meant by commerce or trade, and an enumeration of the essential qualifications of the complete business man. Accounts and the handling of figures are then dealt with, followed by valuable information on banking, diary keeping, arbitration, income tax, life and fire insurance, filing papers, correspondence, shorthand, typewriting, advertising, partnerships, joint stock companies, and a glossary of business terms. With the view of removing the prevailing impression that the modern double entry system of bookkeeping is beyond the grasp or control of the average man of business, pages of a complete set of ruled account books are given, in which are recorded the transactions for a month of an assumed partnership. Explanatory notes on the specimen pages make clear any doubtful points, and the whole details are given with such clearness and simplicity, that a careful perusal of the instructions given would enable any one of ordinary intelligence to adapt the system to any particular business.

NOTES.

Electric Lighting at Pontypool.—We understand that a company has been, or is, in process of being formed to supply electric light to customers in Pontypool, and that, as is very usual in similar circumstances, various opinions are being locally given both for and against electric lighting. We notice in a recent number of the Pontypool *Free Press* that an extract is quoted at some length from the *Journal of Gas Lighting*, commenting upon the unsatisfactory working of the now abandoned electric light at Barnet, but we hope that the people of Pontypool will not be influenced by information conveyed to them in this way, without being able to judge of the facts for themselves. We have repeatedly in the past drawn attention in our pages to the causes of the unsatisfactory lighting at Barnet, pointing out that the system employed there was wrong in the first instance, and that the machinery used was certainly not of the best. There was a disregard of the proper duplication of machinery, which, of course, our best contractors never omit from any central station scheme. We understand that in the case of Pontypool, the contractor for the erection of the machinery is Mr. J. C. Howell, the South Wales representative of Messrs. Crompton and Company, Limited, and as these gentlemen have as large a knowledge of the requirements of central station lighting as anybody in this country, we have no hesitation in assuring prospective users of electric light in Pontypool that they cannot fail to meet with satisfaction if their work is carried out by the firms named. In London, we are now so accustomed to the daily and regular supply of electricity for lighting and other purposes, that we are apt to think hardly when an expression from the provinces reaches us that there are considerable doubts about the satisfactory supply of electricity for these purposes, but most people have already found out for themselves that in electrical matters, as in every other matter of business, the whole question resolves itself into one of first class contracting.

Amalgamation of Electric Companies in New York.—A telegram from New York states that negotiations are in progress with the object of bringing about a union of the Edison and Thomson-Houston Electric Companies. The general opinion in New York is that the negotiations will be brought to a successful conclusion.

Electrochemical Analysis.—This comparatively new method of testing in chemical laboratories is rapidly coming into favour. Experts who have tried it state that it is highly interesting and affords most accurate results. In a recent paper read before the London Chemists' Assistants' Association, Mr. Elwood gave a detailed account of the method with directions for the estimation of most of the common metals, especially urging pharmacists to take it up, since it was a great economiser of time. We understand that electrochemical analysis promises to be of special utility in forensic work.

Electric Lighting at Brighton.—A local Government inquiry was conducted at Brighton last week by Mr. Arnold Taylor, relative to the application of the Brighton Town Council for sanction to borrow £8,500 for electric lighting purposes. The present application is the outcome of a large undertaking which the Corporation had instituted for the purpose of supplying electric light to the borough. The light was started in September last in the parts included in the contract, but there being a large demand for it, it was found necessary to extend the mains. The original estimate did not provide for the mains running up certain roads and the cost of the additional mains would be about £7,100. The extra mains involved extra instruments, the cost of which was calculated at £1,200. Mr. Shoolbred handed in the detailed list of the mains for which the money was required, some of which have already been laid, and stated that a similar cable had been working in Berlin for ten years without the least trouble. Three per cent. he believed to be ample to lay by for depreciation. In reply to questions, Mr. Shoolbred said that outside the compulsory area they were not bound to lay mains unless there was a probability of an income of twenty per cent. on the cost. This concluded the enquiry.

Public Lighting of Llantwit (Neath).—For some time past, the public lighting of Tonna and Melincrystran, both in the parish of Llantwit (Neath), has been a source of considerable trouble and annoyance to the ratepayers. At a forthcoming meeting of the local board, the public lighting question will be duly considered.

Public Lighting of Bridgend.—Last week, a well attended meeting of Bridgend ratepayers was held for the purpose of considering what steps should be taken with regard to the public lighting of the town. It was stated that if the local gas company persisted in enforcing such high rates, some steps should be taken with a view to the introduction of electricity into the town. Eventually, a resolution was unanimously adopted to the effect that the ratepayers indignantly protested against the prices charged for gas, and that unless they were materially reduced, measures would be taken with the view of introducing another means of public illumination.

Gas v. Electric Light.—At a meeting of the Gas Light and Coke Company, the Governor, in moving the adoption of the report and accounts, referred to the effects of the competition existing between their company and the electric lighting companies. He gave, says the *Gas World*, some very interesting figures regarding this effect upon their business. He stated, as an instance, that in a district round Bond Street in three years the company had lost only £4,000 rental. In 1889, the company's rental from this district—which he believed was the best electric-lighted district in the world—amounted to £77,679; in 1890 it was £74,947, and in 1891 it was £73,538.

The Dundee New Electrical Station.—A private meeting of the Dundee Gas Commissioners was held last week, when authority was given to purchase the old cattle market as a site for the new electrical station.

Electrical Forging—Burton System.—A process has been patented by the Electrical Forging Company of Boston, U.S.A., by which metals can be speedily and accurately raised to any desired heat so that they can be readily forged by the special mechanical forging machines which are situated in the vicinity of the electrical apparatus. The system embraces numerous inventions of Mr. Geo. D. Burton; a full description of the company's patents, and their working, appears in the New York *Electrical Engineer*.

Heavy Resistances.—Nothing seems easier to design says our contemporary, *Industries*, than a resistance capable of taking several horse-power, as all that is necessary is a few yards of spiral iron wire. In practice, however, resistances come out expensive and cumbrous articles. There is, however, a very simple way of making resistances which will absorb large powers without trouble. The required resistance is made up in lead wire, and this is immersed in water. Under 100 volts a little of the electricity crosses by the water, so the current cannot be found accurately by dividing the pressure by the resistance of the lead. The lead does not waste, as one side peroxi lises and protects itself. It is surprising what large currents can be taken up in this way. For temporary work, a piece of platinoid wire can be used. A spiral some 3 inches long, consisting of a few feet of wire, placed in a bucket of water, will take two or three horse-power, till the water is boiled away. These methods are so very convenient, that they should be more widely known among electrical engineers.

Telegraphic Service in Nicaragua.—A concession has been granted by the Nicaraguan Government to Dr. Louis Cruz for the establishment of a complete telegraphic service in Nicaragua. All the material for the construction of the one will be admitted free of duty, and during the continuance of the concession no other similar privilege will be granted, except with the Canal Company, and the various railroad lines will not be prohibited from employing private telephones in the regular course of their own business. The Government will be furnished, free of expense, with twenty-five instruments, with the necessary connections with the central office and all the lines of the company. Many other important privileges are given to the concessionaire, who is authorised to transfer his rights to an operating company should he so desire.

Drum Armature Windings.—We notice a letter in *Industries* from Mr. Emil Huber, of Oerlikon, regarding a patent granted to Mr. R. E. Crompton, for improvements in drum armatures of dynamo machines. The writer states that the Maschinenfabrik Oerlikon have built a very large number of machines of exactly the same design of armature as that of Mr. Crompton, this apparatus therefore being by no means a novel invention. Two of these machines of 500 H.P. capacity each, were built for the Aluminium Company, at Neuhausen, and were erected two years ago. He further states that machines of this type were sent to England six months before Mr. Crompton's patent was issued. Emil Huber closes his letter by stating that the idea is not a new invention, but merely a new patent.

The Relative Merits of Lightning Rods.—When we consider what a long time has elapsed since buildings were first "protected" by lightning conductors, it seems remarkable that there should still be any divergence of opinion as to the proper form which these conductors should take. We have not even adopted a uniform kind of "lead" yet; while everywhere we see most important buildings, even monuments and ruins of the greatest historic value that could never be replaced when once destroyed, "protected" by the most crude and imperfect means. We certainly are no advocates of "grandmotherly legislation," but it does appear as though some stringent enactment were necessary in order that dangers from lightning may be properly guarded against. We are glad to notice that Dr. Hess has been turning his attention to the relative merits of different kinds of points for lightning conductors. He has examined a number of conductors that had been struck by lightning and his conclusions are briefly as follows:—The fusion of the points on lightning-rods causes no danger because no scattering of fused drops occurs. Smooth and fine points receive the lightning in what may be termed a concentrated form, while sharply, angled, ribbed and blunt points divide it into what Dr. Hess calls "threads." Platinum needles and tips have no advantage over copper points. Some lightning strokes are capable of making brass wire, 7·2 mm. (say 0·29 inch) thick, incandescent, hence unbranched copper conductors should never be thinner than 7 mm. We must remember that a discharge through a lightning conductor is so brief that the laws of steady flow do not hold good; and that it is of advantage, in order to diminish the risk of lateral divergence, to render the current more uniform, and therefore the capacity and consequently the surface of the conductor should be increased. If lightning-rods were made of broad flat plates more frequently, instead of being compact rods, we should hear less of the inefficiency of lightning conductors than we do.

The Central London Railway.—The engineers of the authorised Central London Railway have prepared and deposited the parliamentary estimate of the cost of extending this railway, as proposed in the bill deposited for this session, from Mansion House Street to Liverpool Street Station. The estimate gives the total cost of this extension, which will be just over five furlongs in length, at £391,407, but against this is set off the sum of £296,420 that would have been required for the construction of the authorised railway east of Mansion House Street, which is, under this extension scheme, to be abandoned. The net cost of the extension is therefore reduced to the sum of £94,987. Of the total sum, tunnelling is estimated to absorb £127,480; stations, £77,650; land purchase, £150,000; permanent way, £5,240; and contingencies, £31,037.

Double Carbon Arc Lamp Litigation.—According to our contemporary, the *Western Electrician*, great activity is being displayed by the Brush Electric Company in bringing law suits against the users of double carbon arc lamps other than its own. It seems that actions are being brought against eight or nine different firms; none of the suits, however, are expected to come on for trial before three or four months have elapsed. In a case which was tried in America about a fortnight ago—Brush Company *v.* Electric Construction Corporation—it is stated on the authority of a New York dispatch that the United States Judge Lacombe has handed down a final decree "perpetually enjoining and restraining the defendants from making, using or selling any arc light electric lamp in which two or more pairs of carbon are independently regulated, controlled and burned successively."

Copper Statistics.—An appreciable increase is visible in supplies of copper with a decided falling off in demand, according to the monthly statistics. From *Industries* we understand that the supply in England and France and afloat thereto at the end of January, was 57,462 tons, or an advance of 1,400 on that at the close of 1891. Deliveries in England and France were 5,587 tons, showing a decrease of nearly 5,000 tons from the previous month, and 6,670 tons less than in January, 1891.

Shoreditch Workhouse and Electric Lighting.—We hear that an electric lighting committee of five members has been nominated by the Shoreditch Board of Guardians. This committee will act with their architect (Mr. Smith), who has superintended the fitting of several establishments with the electric light, and will visit these installations and report upon the best scheme for lighting the workhouse.

Weston-super-Mare and Electric Lighting.—At a recent meeting of the Weston-super-Mare Town Commissioners, the Electric Lighting Committee reported their visit to Taunton, and came to the conclusion, after visiting the various streets after dark, that the electric lighting, on the principle adopted in Taunton, left a great deal to be desired. Considering that the extra cost of lighting the streets of Weston-super-Mare would be about £800 per annum, the deputation recommended the board to postpone the further consideration of the matter. The minute was confirmed without discussion.

The Edison-Lalande Cell.—In a recent number of the *Canadian Magazine* we notice a letter from a correspondent regarding the Edison-Lalande Cell. The writer (Mr. W. B. Shaw) states that he has handled nearly every type of Edison Lalande Cells, and as a result of practical experience, he would not recommend anyone to adopt them. We extract the following remarks from his letter:—"I positively deny the statement that there is no local action going on in the cells when not in use, for I have had zincs eat through and drop off when left *continually on open circuit*. I was told the fault lay in not having oil enough on top of the potash solution; this also I proved was not the nature of the trouble by setting up an experimental set of 4 cells with different thicknesses of oil layers. I went so far as to try painting some of the zincs with asphaltum, and others with shellac, at the solution line; this not even producing any marked benefit. . . ." After referring lengthily to the matter of cost and mathematical particulars, he says:—"The Edison-Lalande cell has good practical points, and is a cell demanded, but its present form will not give satisfaction to the consumer; what the trouble is, exactly, I am not competent to state, but imagine it to be impurities in the potash; varying strength of same, and too much used per cell.

The Dundee Telephone Case.—The action at the instance of the National Telephone Company, Limited, against Messrs. John Milne and Son, merchants, Dundee, for rent or subscription for the use of the telephone for the year ending November next was on the roll of the Small Debt Court again last week. It will be remembered that the defence was that the service was inefficient. Last week it was intimated that the action had been settled, the defendant having paid the current year's subscription (£8 10s.) with small debt expenses, and the company, on the other hand, having agreed to bring their agreement with Messrs. Milne to a close at November next if the parties so desired.

The Trial of the Sims-Edison Torpedo.—A number of scientific men met at Portsmouth on Monday last to witness the first public trial in England of the Sims-Edison electrical torpedo. Mr. Sims, the inventor, pointed out to the party that the best results possible were not expected, owing to the worn nature of the torpedo, and after explaining the system, the experiment was tried. According to the *Standard*, so far as could be seen, there was no difficulty or hitch about the matter, nor any deficiency in mechanism that could not be easily overcome. Our daily contemporary thinks, however, that there is still much to improve before the principle of this machine can be turned to valuable account, and that its superiority over the present Brennan system does not appear to be so very obvious as to warrant the large sum of money paid for that machine.

Telegraphy Between Valparaiso and Buenos Ayres.—It is authoritatively announced that in a very short time the new telegraph line will be completed between Valparaiso and Buenos Ayres. This line will connect at Buenos Ayres with the coast line from Buenos Ayres to Europe by way of Montevideo and the Brazilian ports. It will be operated from Valparaiso in connection with the west coast cable line.

Telegrams for French Guiana.—The *London Gazette* states that the telegraph rates for French Guiana, by any of the following companies, are Cayenne, 10s. 8d. per word, and other places 10s. 10d. per word :—Anglo-American Company, Direct United States Cable Company, Paris and New York Company, Western Union Company, and Commercial Cable Company.

Electric Lighting of Glasgow Streets.—Next week a deputation of the Glasgow Town Council will pay a visit to London to obtain a thorough insight into the electric street lighting system, which is being largely carried out in the metropolis, in view of the Town Council's decision to light the principal streets in the centre of the city by electricity.

A Cable to the Azores.—A contract was signed last week by the Minister of Public Works at Lisbon and the representative of the Telegraph Construction and Maintenance Company for the laying of a cable between Lisbon and the Islands of St. Michael, Fayal, Pico, St. George, and Terceira, in the Azores. The cable is to be completed in a year.

Electric Light in the Sheffield Council Chamber.—The Sheffield Council Chamber was lighted last week for the first time by electricity. In the midst of a discussion the chamber was suddenly illuminated with the light, and the applause which welcomed it was very general. The work has been carried out by the Sheffield Exchange Company.

Electric Lighting at West Cowes.—At the meeting of the West Cowes Local Board last week, it was proposed that the application of the Isle of Wight Electric Lighting Company to the Board of Trade for a license to light West Cowes be approved, and that the consent of the Board be given to the company's application, under the Electric Lighting Acts, 1882 to 1890. Eventually, after discussion, a vote was taken and the resolution carried.

New Journal.—We have received a copy of the first number of a new electrical journal which has just been started in Rome, under the title of *L'Elettricista*. The journal seems to be run on very similar lines to some of our other foreign technical contemporaries, and we wish it every success.

The Bradford Central Station.—Referring to our note last week regarding Alderman Priestman's remarks at the Council Meeting, in which he referred to the coal consumption, we now learn that he was speaking of the amount and not the cost of the coal consumed per unit, therefore the figures which were given on the responsibility of the newspapers should be 12·58 lbs. per unit, not 12·58d.

Coast Communication.—Sir Michael Hicks-Beach has made the gratifying announcement that the Government is inquiring into the cost of supplying electrical communication between lightships and lighthouses and telegraph stations ashore. Sir Michael has misunderstood an estimate of £100,000 which was thought sufficient to cover the cost of putting coastguard stations in communication with one another, and has included in this the establishing of communication with lighthouses and lightships for which, as he says, it is obviously inadequate.

Electric Light on the Jura-Simplon Railway.—The Jura-Simplon Railway, says the *Pall Mall Gazette*, is the first Continental line on which the electric light has been introduced. Tne expenses are comparatively very small, as the company has sufficient water power at Freiburg. Every train passing through the above-mentioned town is supplied with sufficient electrical energy for the journey it is about to undertake.

Theatre Lighting in America.—The Fifth Avenue Theatre, in New York, and the Columbia Theatre in Brooklyn, are both being fitted with the electric light. The work in each case is being carried out by Messrs. H. Ward Leonard & Co., of New York.

The Electric Light in Bavaria.—Although the contract for the turbines for the proposed central station in the town of Erding, in Upper Bavaria, has been given to the Maschinenbau-actiengesellschaft, in Augsburg, nothing has been done as regards the electric portion of the work. Altogether, 12 firms, including some of the most important in the country, sent in tenders for the work.

Telephones in the United States.—The earnings of the Bell Telephone Company in the United States amounted last year to £625,600, being an increase of £51,800 as compared with the previous year.

Electric Wires in New York.—There are now 143 high tension circuits comprising 528 miles of electric conductors underground, and 383 miles of low tension circuits in the Edison conductors in New York.

Electric Lighting in Bremen.—On the 10th inst. the Bremen Town Council decided to enter into an agreement with Messrs. Siemens and Halske for the electric lighting of that town. The total cost of the installation including the buildings is estimated at £95,000. According to the plans there will be one generating station from which the current will be sent to two sub-stations situated in the town proper. Here will be installed batteries of accumulators which will be charged by the current, and which will supply direct to the consumers. The initial capacity of the station will be 30,000 lamps.

Isle of Man International Exhibition.—It is proposed to hold an International Exhibition of Industry, Science, and Art at Belle Vue, Douglas, during the present year. Accommodation will be provided for, among others, sections treating of mining, engineering, machinery in motion and at rest, and heating; illuminants, such as electricity, gas, oil, &c.; electrical engineering and inventions, &c. The grounds and buildings will be lighted by electricity and gas. The exhibition is to be opened on July 4th, and will terminate at the end of September. The offices are at Belle Vue.

The Electric and Cable Railway Schemes in Parliament.—It is proposed, says the *Times*, that a joint committee of Lords and Commons shall be appointed to consider the best method of dealing with the electric and cable railway schemes within the limits of the metropolis brought before Parliament this session. The duty of such a committee would be to report whether underground railways worked by electricity or cable traction are calculated to afford sufficient accommodation for the present and probable future traffic, whether any of the schemes propose satisfactory lines of route, upon what terms and conditions the subsoil should be appropriated, and whether any of the schemes should be proceeded with during the present session.

North of England Institute of Mining Engineers.—At a general meeting of the members of this Institute, a paper was read by Mr. Henry Palmer on "Notes on an electric transmission plant at East Howle colliery." Mr. D. Selby Bigge also read a paper on "Electricity and its application to mining operations."

Salford and Electric Lighting.—A deputation from the Gas Committee of the Salford Corporation paid a visit on Saturday last to the Electric Exhibition at the Crystal Palace. Under an order obtained from the Board of Trade, the Corporation are allowed until August next the exclusive right of controlling the supply of electricity for lighting purposes in the borough, and the inspection of the various types of plant now on view at the Crystal Palace has been arranged with the object of enabling the committee to make some definite recommendation in the matter. On their return to Salford, the deputation will prepare a report, which will be considered at the next meeting of the Gas Committee.

Direct Telegraphic Communication with the West Indies.—The first news despatch received direct by cable from the Bahamas came last Wednesday evening through Reuter's agency, announcing the opening of the Legislature at Nassau by the Governor.

Telegraphs—Fort Salisbury to the Cape.—A Reuter's telegram from Fort Salisbury states that telegraphic communication was on 17th inst. finally established between that port and the Cape. The first message which was sent over the wire was a congratulatory telegram despatched to London.

The Government and Telephones.—Dr. Cameron has given notice to call attention, on the Civil Service estimates, to the relations between the Postal Telegraph Department and the telephone system. He will bring forward a motion in favour of the acquirement of the telephone system by the Post Office.

Electric Light at the Manchester Central Railway Station.—Last Friday the Manchester Central Railway Station was experimentally lighted by electricity. For the passenger department 40 arc lamps (11 ampère) of the Brockie-Pell construction (with the wheel-clutch regulating arrangement) are provided. The various offices and the bookstall are supplied with 200 incandescent lamps of the Edison type each of 16 candle-power. The installation for the goods department is not completed, but it is to be supplied with 70 arc and 60 glow lamps. The lighting on Friday last was proceeded with in sections. Some slight pulsation, we understand, was observable in the arc lamps, incidental to the trial, but the improved appearance of the station was the subject of general comment.

Leeds Corporation and Electric Lighting.—We notice that last week a letter appeared in the *Leeds Mercury* from a number of influential business men in Leeds confidently calling upon the authorities themselves to supply them with the electric light, or to allow terms to electric light companies sufficiently favourable to induce them to undertake the work. The following day a letter appeared in the *Yorkshire Daily Post* from the solicitors of the Yorkshire House-to-House Electricity Company, Limited, stating that the company's prospectus will shortly be issued, and as soon as the necessary capital has been raised operations will be at once commenced.

Communicating with the Guard.—Referring to our leaderette on this subject in our last issue, we learn from a correspondent that the method we described is exactly similar in every particular, excepting that of the luminous paint, to one carried out over 25 years ago on the South Western Railway, and which was run very successfully for a long time. The system, we understand, was patented, and described in a paper before the Institution of Civil Engineers. There are trains on the Great Northern and South Eastern Railways which are similarly fitted, and the same system of communication has also been adopted elsewhere.

NEW COMPANIES REGISTERED.

H. S. Cropper and Company, Limited.—Capital £15,000 in £10 shares. Objects:—To acquire and carry on the business of manufacturers of lace making machinery, ironfounders, mechanical engineers, &c., carried on by H. S. Cropper, J. Cropper and S. Thacker, at Minerva Works, Great Alfred Street, Nottingham; to carry on the business of electricians, suppliers of electricity for the purposes of light, heat, motive power or otherwise, and manufacturers of, and dealers in all apparatus and things required for, or capable of being used in connection with the generation, distribution, supply, accumulation and employment of electricity. Signatories (with one share each): H. S. Cropper, Private Road, Mappersley, Nottingham; J. Cropper, 1, Gill Street, Nottingham; S. Thacker, 32, Ball Street, Nottingham; S. H. Cropper, Private Road, Mappersley, Nottingham; A. C. Cropper, 11, Arno Avenue, Sherwood Rise, Nottingham; G. Shaw, 19, Rookwood Road, Nottingham; W. D. Pratt, Victoria Crescent, Private Road, Sherwood, Nottingham. Registered, without articles of association, on the 9th inst., by Hind and Robinson, 8, Stone Buildings, Lincoln's Inn, W.C.

Sea Fishing Company, Limited.—Capital £10,000 in £1 shares. Objects:—To acquire by way of purchase license or otherwise, any rights in any inventions for the, purpose of fishing by the attraction of the electric light, or for any purposes in connection with fishing, and to work and develop the same. Signatories (with one share each): J. Harris, Moraston Lodge, Sydenham, S.E.; O. Stokes, South View, Sydenham Road; W. Hanning, 5, Copthall Buildings, E.C.; J. Harold, Augusta House, West Ham, E.; H. W. Lourd, 7, Palamos Road, Leyton; J. C. Belcher, 41, Marlborough Road, Brighton; J. Clarke, Grange Lodge, Beauchamp Road, Upper Norwood. The number of directors is not to be less than two nor more than seven, the first to be appointed by the above subscribers. Qualification one share; remuneration £250 per annum. Registered on the 13th inst., by J. Herbert Farmer, 35, Walbrook, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Direct United States Cable Company, Limited.—The annual return of this company made up to the 29th ult., was filed on the 6th inst. The nominal capital is £1,300,000 in £20 shares. 60,710 shares have been taken up, all of which have been issued as fully paid. Registered office, Winchester House, Old Broad Street, E.C.

Electricity and Electrical Engineering Newspaper Company, Limited.—The registered office of this company has been removed from 6, White Hart Street, Paternoster Square, E.C., to 34, Cannon Street, E.C. (filed on January 13th, 1892.)

Electrolytic Caustic Soda and Chlorine Trust, Limited.—The statutory return of this company, made up to October 29th, 1891, was filed on November 24th, 1891. The nominal capital is £10,000 in £10 shares, all of which have been taken up and 500 issued as fully paid, upon the remaining 500 £6 per share has been called and paid. Registered office, 23, Queen Victoria Street, E.C.

Freedman Battery Company, Limited.—The annual return of this company, made up to the 2nd ult., was filed on the 7th ult. The nominal capital is £2,000 in £1 shares. 1,865 shares have been taken up, 5s. per share called, and all calls paid. Registered office, 66, Berners Street, W.

S. Z. de Ferranti, Limited.—The first annual return of this company, made up to the 12th December, 1891, was filed on the 24th December. The nominal capital is £100,000, divided into 2,000 5 per cent. preference and 8,000 ordinary shares of £10 each. All the shares have been taken up, and 1,993 preference and all the ordinary shares have been issued as fully paid, while upon the remaining 7 preference shares the full amount has been called and paid. By special resolution passed January 11th, 1892, and confirmed January 26th, 1892 (filed on the same day), the 5 per cent. preference shares were changed to 7 per cent. preference shares. Registered office, St. Benet Chambers, Fenchurch Street, E.C.

Field's "M. P." Development Association, Limited (mechanical and electrical engineers, suppliers of electricity, &c.)—The statutory return of this company made up to December 14th, 1891, was filed on December 29th. The nominal capital is £100,000 in £1 shares, 90,000 of which have have been taken up. 80,000 of these have been issued as fully paid, and upon the remainder the full amount has been called and paid. Registered office: 13 and 14, Abchurch Lane, E.C.

Foreign Electric Date and Time Stamp Company, Limited.—The registered office of this company has been removed from 90 and 91, Queen Street, Cheapside, E.C., to 20, Bucklersbury, London, E.C.

W. T. Henley's Electric Light and Power Company, Limited.—The annual return of this company, made up to the 13th ult. was filed on the 21st ult. The nominal capital is £100,000 in £1 shares; 6,918 shares have been taken up, and the full amount called, resulting in the payment of £6,911, and leaving £7 in arrears. Registered office: 27, Martin's Lane, Cannon Street, E.C.

LEGAL.

Gent & Co. v. Edge and Sons.—A case came on before the Leicester County Court last week, in which Messrs. Gent & Co., electrical engineers, Leicester, sued Messrs. Edge and Sons, chain makers, Coalport Works, Shifnall, for £3 11s. 2d. for goods supplied. Mr. Simpson appeared for plaintiffs, and Mr. Fowler for the defendants.

Mr. SIMPSON said the defendants ordered a telephone and fittings from the plaintiffs in June, 1891. In July it was sent back because it did not work well, and plaintiffs re-adjusted it, finding that it had not been properly dealt with. Nothing more was heard until November, when defendants again complained that the telephone would not work. It was sent to plaintiffs, who found it had not been properly connected. They again adjusted it, and sent the instrument back to the defendants, who refused to accept it.

Plaintiffs' manager said the reason the telephone would not work was, that it had not been properly treated and connected. It was a pattern of instrument which had now been superseded, but was a good one of its kind. The one supplied to defendants was a perfect instrument, but improvements had since been made, and that kind was no longer sold by plaintiffs. It was the last of the kind they had, and they had not sold another since. They could not take it back again, because they would not be able to dispose of it.

Plaintiffs' foreman said when the telephone was returned the first time, he found a plate had been moved, and put back wrongly. When it was adjusted the instrument worked well. It had again been tampered with on the second occasion.

Mr. FOWLER contended that the fault lay in the instrument, which was an imperfect one. An expert was employed to put it up, and that was done exactly in accordance with the diagrams and instructions issued by the plaintiffs, but it would not work.

Judgment for the plaintiffs.

Andrew and Company v. Crossley and Company—Crossley and Company v. Andrew and Company.—This was an appeal which came before Lords Justices Lindley and Kay on Wednesday last against a decision of Mr. Justice Chitty. An important question was raised as to the operation of an order, made under section 18 of the Patents Act, 1883, giving leave to amend the specification of a patent. In the present case Messrs. Crossley and Co. were the owners of a patent granted in 1881 for improvements in gas motor engines, &c. An action having been brought in February, 1890, and a motion made by Messrs. Andrew & Co. for an injunction to restrain Crossley & Co. from alleging that Andrew & Co. had infringed their patent, and from making threats of taking proceedings in reference to the alleged infringements, the motion stood over on an undertaking by Crossley & Co., embodied in an order of March 28th, 1890, to bring an action against Andrew & Co. for infringement so soon as a disclaimer by Crossley & Co. of certain claims in the specification of their patent should be allowed. The two actions having been referred by consent to an arbitrator, and it having been proposed on behalf of Crossley & Co. when opening their action before the arbitrator to put in the amended specification, objection was taken on behalf of Andrew & Co. as to its admissibility in evidence, on the ground that on June 11th, 1890, being the date of the issue of the writ, the amendment had not been actually made, and that sub-section 10 of section 18 prevented the use of the amended specification. The arbitrator held that the amended specification could not be admitted. Mr. Justice Chitty held that the amended specification was admissible, on the ground that the proceedings for amendment terminated with the leave to amend. Messrs. Andrew and Co. appealed.

Mr. Hopkinson, Q.C., and Mr. J. C. Graham ware for the appellants. The Attorney-General (Sir R. E. Webster, Q.C.) and Mr. W. N. Lawson, for the respondents, were not called upon.

After some lengthy remarks by Lord Justice Lindley and Lord Justice Kay the Court dismissed the appeal.

BUSINESS NOTICES, &c.

R. Hornsby & Sons.—Messrs. R. Hornsby & Sons, Limited, of Grantham, have obtained an order for six tandem compound condensing vertical engines for the Manchester Corporation electric light installation. These engines are to have 10½-inch and 16-inch cylinders, with a 2-feet stroke, and will be constructed to give off 90 brake horse-power, with a piston speed of 480 feet per minute, the consulting engineer being Dr. Hopkinson, of Victoria Street, Westminster.

Ship Lighting.—Last Saturday afternoon there was launched at the Caledon yard of Messrs. W. B. Thomson & Co., Limited, Dundee, an iron screw steamer for the Clyde Shipping Company. Electric light has been fitted throughout by Messrs. Paterson and Cooper, under the superintendence of Mr. Martin, their local representative. The installation includes several important improvements in ship lighting.

The Electric Light at Charing Cross.—The number of electric light installations in the West End is at present being increased by the addition of the Union Bank of London in Trafalgar Square, whose offices are being installed by Messrs. Drake & Gorham, of Westminster.

Woodhouse and Rawson.—We have received from this firm a set of price sheets of telephones and transmitters for domestic and long-distance telephony.

Tenders Wanted.—Melbourne.—Separate tenders are invited by the Council of the City of Melbourne for the supply and delivery of: 1. Electric light plant. 2. Cables and insulators. Tenders will be received until April 2nd, and must be addressed to the Right Worshipful the Mayor of Melbourne, Victoria, endorsed "Tender for ——" (as the case may be). Mr. John Clayton, town clerk, Town Hall, Melbourne.

Tenders Wanted.—Dresden.—Tenders are being invited by the Inspection Supérieure of Telegraphs at Dresden for the supply of 50 tons of galvanised iron wire, 9 cwt. of copper wire, 20,000 porcelain insulators with iron supports, 5,000 zinc cylinders, 1,000 copper cylinders, and 50 tables for Morse instruments. Tenders are to be sent in by February 25th.

Tenders Wanted.—Spain.—Tenders are being invited for the supply of 25,000 telegraph insulators, 3,000 telephone insulators, 60 tons of wire, 4 millimetrés thick; and 17,223 posts of various dimensions. Tenders should reach the La Direction Générale des Communications, Calle de Carretas, 10, Madrid, by March 10th.

Tenders Wanted.—Hanley.—At a recent meeting of the Hanley Town Council it was resolved, on the proposition of the Electric Lighting Sub-Committee, to advertise for specifications and estimates of the cost of plant and distributing mains and machinery for lighting by electricity the area contained in the second schedule of the Hanley provisional order.

Tenders Wanted. — Heckmondwike. — Mr. W. B. Hutchinson has now finished the Heckmondwicke specification for electric lighting, and tenders are invited. Plans may be obtained at the surveyor's office, and a copy of the specification may be seen at 22, Paternoster Row.

Electricity.—Tenders are invited for lighting the exhibition buildings and grounds at Earl's Court during the coming season, from the beginning of May to the end of October, 1892. Particulars can be obtained on application, in writing, to the Secretary of the Earl's Court Exhibition Syndicate, Limited, West Brompton.

Cleckheaton New Town Hall Buildings.—The New Town Hall Buildings at Cleckheaton, which have just been opened, are lighted throughout by electricity, the contract having been carried out by Messrs. J. H. Holmes & Co., Newcastle-on-Tyne.

Fire.—A fire broke out early yesterday morning in Gray's Inn Road. The premises of Messrs. Hodges & Todd, electrical engineers, were completely gutted by it. The firm is, however, engaging new premises, and business will be carried on as usual.

Mavor and Coulson.—The employés of Messrs. Mavor and Coulson, electric lighting engineers, had their annual *conversazione* and dance in the Trades' Hall, Glassford Street, on Friday.

CITY NOTES.

The India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.

THE directors' report for the year ending December 31st, 1891, states that the accounts show the net profit for the past year to be £79,102 8s. Adding £39,970 17s. 10d. brought forward, and deducting £20,800 interim dividend paid in July, there remains a disposable balance of £98,273 5s. 10d. The directors have added £25,000 of this balance to the reserve fund (raising it to £325,000), and recommend the distribution of a dividend of 10s. and a bonus of 5s. per share, free of income tax, amounting to £31,200, making, with the interim dividend, a total payment for the year of 12½ per cent., and leaving £42,073 5s. 10d. to be carried forward. The increase in the sales of the company's general manufactures continues. The cable department has been fairly well employed. More than 1,600 miles of cable have now been manufactured for the South American Cable Company; and it is expected that the whole length contracted for will be made and laid by midsummer. The efficiency of the works and machinery has been fully maintained. Mr. Scott and Mr. Jarvis, the directors retiring by rotation, offer themselves for re-election. Mr. Weise is re-eligible as auditor.

BALANCE-SHEET, *December 31st*, 1891.

CAPITAL AND LIABILITIES.

DR.	£	s.	d.
Amount of authorised share capital ...	812,000	0	0
To Share capital—Amount subscribed and paid on authorised issue of 41,600 shares of £10 each	416,000	0	0
„ Mortgage debentures	200,000	9	0
„ Reserve fund	325,000	0	0
„ Steamers' maintenance fund	10,000	0	0
„ Debts and loans owing by the company ...	83,329	13	8
„ Bills payable	16,608	17	0
„ Unclaimed dividends	7	0	0
„ Proposed dividend, 5 per cent., and bonus of 2½ per cent.	31,200	0	0
„ Amount carried forward to 1892, as below ...	42,073	5	10
	£1,124,218	16	6

ASSETS AND EXPENDITURE.

CR.	£	s.	d.
By Freehold and leasehold premises (Silvertown, Persan, London and Liverpool), machinery and steamships	483,546	2	11
„ Debts owing to the company	82,487	0	10
„ Cash with bankers and in hand	22,477	8	9
„ Bills receivable	4,432	5	4
„ Stock-in-trade, including cable and expenditure on account of contracts	347,857	14	7
„ Debenture and shares in other companies ...	25,290	10	0
„ Cash, stock, &c., at Persan and other agencies	158,127	14	1
	£1,124,218	16	6

PROFIT AND LOSS ACCOUNT.

DR.	£	s.	d.
To Salaries, interest, rent, rates and taxes, repairs, and general expenses	64,008	7	2
„ Bad debts	902	3	2
„ Income tax	1,326	12	0
„ Depreciation written off buildings and machinery	23,235	7	10
„ Directors' remuneration (minimum)	2,000	0	0
„ Balance—profit for the year, carried down ...	82,102	8	0
	£173,574	18	2

CR.	£	s.	d.
By gross profit, including interest on securities, and after charging commission and depreciation of steamships	173,574	18	2
	£173,574	18	2

	£	s.	d.
To Addition to reserve fund	25,000	0	0
„ Interim dividend of 5 per cent. paid in July, £20,800; proposed dividend of 5 per cent., £20,800; proposed bonus of 2½ per cent., £10,400	52,000	0	0
„ Balance to be carried forward to 1892	42,073	5	10
	£119,073	5	10

	£	s.	d.
By Balance brought down £82,102 8 0			
Less additional remuneration due to directors after payment of 10 per cent. to shareholders ... 3,000 0 0			
	79,102	8	0
„ Amount brought forward from 1890	39,970	17	10
	£119,073	5	10

I have examined the above accounts with the books and vouchers and the returns from the Persan and home agencies, together with the securities representing the investments held by the company, and certify to their correctness in accordance therewith.

The subsidiary books have, as usual, been examined in totals; and I have had produced to me the inventories of stocks on hand, certified by the Works Manager.

J. WEISE, *Auditor.*

LONDON, *February* 6th, 1892.

Westminster Electric Supply Corporation, Limited.

THE directors' report for the year 1891 states that the business of the corporation is making satisfactory progress, for although two of the stations were not in work until the end of March, and one is still in the builder's hands, the accounts of the past year show a considerable profit upon the working, after making provision for bad and doubtful debts, allowing a fair amount for depreciation, and writing off a proportion of the preliminary expenses and suspense account. In their report last year, the board stated that current was being supplied to the equivalent of about 12,000 lamps of 8 C.P. At the present time current is being supplied to 67,500 lamps of 8 C.P., while applications are signed for a further 5,083 lamps of 8 C.P. The application to Parliament for permission to supply the Northern District of Westminster was successful, the Royal assent to the Bill having been given on July 3rd, 1891. Mains have now been laid in all the scheduled streets throughout the area of supply, as also in every other street where the expenditure has been justified by the demand for current, both in the original and additional order. The total length of roadway along which mains have been laid up to the present date is about 31 miles. This includes a total of about 123 miles of "ways" along which 89 miles of copper have been drawn. The directors have every reason to believe that the corporation's supply, which has so successfully been given to the Houses of Parliament, will be extended to other Government offices at no very distant date. Two of the stations of the corporation which had not been finished at the date of the last general meeting (the Mayfair Station in Davies Street, and the Belgravia Station in Eccleston Place), commenced to supply current in March last, and, together with the Westminster Station in Millbank Street, have since been constantly at work. The reports from consumers and others as to the quality of the light supplied have been very gratifying, and the increase in the number of applications for current received may, no doubt, be ascribed to this fact. As shown in the accompanying accounts the net revenue of the corporation for the past year is £3,160 4s. 3d., and this sum the board consider should be carried forward. The balance of the authorised share capital, viz., £85,235 in 17,047 shares of £5 each, was, in accordance with the resolution of the shareholders at the general meeting in February last, issued at par, and was duly subscribed for; many of the original shareholders increased their holdings, and a number of the consumer's on the corporation's circuits invested in the shares. The whole of the authorised capital has now been subscribed, and paid up in full, and it is very satisfactory to the board to be able to state that there is not a single unpaid call. The directors have not made any public issue of the debenture capital for which powers are given in the articles of association, but have allotted £29,400 in 5 per cent. mortgage debentures to applicants, many of whom had applied for ordinary shares of the corporation. The auditors, Messrs. Cooper Brothers & Co., retire, and, being eligible, offer themselves for re-election.

ABSTRACT OF ACCOUNTS to December 31st, 1891.

CAPITAL ACCOUNT.

DR.	£	s.	d.
To expenditure per last account	120,608	13	7
„ further expenditure to December 31st, 1891 ...	177,032	4	2
„ Balance of capital account	31,759	2	3
	£329,400	0	0

CR.	£	s.	d.
By Ordinary shares	299,500	0	0
„ Founders „ 100 £5 each	500	0	0
„ Debentures 294, 5 per cent. mortgage	29,400	0	0
	£329,400	0	0

REVENUE ACCOUNT.

DR.	£	s.	d.
To Generation of electricity } „ Distribution of electricity }	8,713	7	11
„ Proportion of rents, rates, and taxes	1,567	11	3
„ Proportion of management expenses	3,246	0	5
„ Proportion of law and parliamentary charges ...	294	13	2
„ Depreciation	1,400	0	0
„ Insurance	91	6	9
„ Balance to net revenue account	4,142	8	4
	£19,455	7	10

CR.	£	s.	d.
By Sale of current per meter	18,131	5	0
„ „ „ under contract	981	11	8
„ Rental of meters, converters, &c.	288	18	8
„ Transfer fees	53	12	6
	£19,455	7	10

NET REVENUE ACCOUNT.

DR.	£	s.	d.
To Interest on calls in advance, and mortgage debentures	1,218	13	3
„ Amount allowed for bad debts	98	1	8
„ Amount written off preliminary expenses and suspense account	1,000	0	0
„ Balance carried forward	3,159	14	3
	£5,476	9	2

CR.	£	s.	d.
By Balance from account	714	12	6
„ „ „ revenue account	4,142	8	4
„ Rent from freehold property	114	13	4
„ Interest on temporary deposits	474	15	0
	£5,476	9	2

GENERAL BALANCE SHEET.

DR.	£	s.	d.
To Capital account	329,400	0	0
„ Sundry creditors on open accounts	15,322	3	0
„ Net revenue account, balance at credit thereof ...	3,159	14	3
„ Depreciation account	1,000	0	0
„ Sinking fund on buildings and leases	400	0	0
	£349,281	17	3

Cr.	£	s.	d.
By Capital account	297,640	17	9
„ Cash at bankers	1,350	17	3
„ „ on lease against securities	30,000	0	0
„ Sundry debtors for current } „ Other „ ... }	10,625	5	6
„ Stores on hand	99	4	4
„ Deposits with vestries, &c.	184	14	10
„ Preliminary expenses and suspense account, less amount written off for the year 1891	9,380	17	7
	£349,281	17	3

Newcastle and District Electric Lighting Company, Limited.

THE fifth ordinary general meeting of this company was held on Monday last at the offices of Messrs. Leadbitter and Harvey, Westgate Road. Mr. J. D. Milburn, chairman of directors, presiding.

In their annual report the directors congratulated the shareholders on the fact that the prospects of the company continue good. The installations connected to the mains during the year were equal to 4,000 ten candle-power lamps, bringing the total up to about 11,000, and 206,017 units of electrical energy had been supplied. The company maintains amicable relations with its consumers, and trusts that the consumption may, ere long, increase to a sufficient extent to enable the directors to recommend a reduction in the price of current. The gross earnings during the year amounted to £1,860 15s., and after making provision for depreciation account and reserve fund, and writing of £200 from formation expenses, the directors were able to recommend a dividend at the rate of 2½ per cent. for the half-year ending December 31st, which, together with the interim dividend paid in July last, made 5 per cent. for the year.

The CHAIRMAN, in moving the adoption of the report, said: I ask permission to say a few words concerning the position and progress of our company. I have to congratulate the company upon the steady progress which has been made since its commencement. Our receipts during the financial year ending December 31st last have amounted to £4,796 18s. 6d., as against nearly £220,000 of receipts by the gas company. We have no war with the gas company. The first time I had the honour of addressing you, I, on behalf of your directors, intimated that the Newcastle and District Electric Lighting Company did not intend to enter into any insane competition with gas. We wished to supply an artistic, healthy, and exhilarating light at a higher price than gas. We have hitherto steadily pursued this policy with a fair share of prosperity for ourselves, and with the result that, instead of doing harm to the gas company, its business has actually increased, and it is even now seeking a large amount of fresh capital to allow of extensions. We have, therefore, actually exhilarated the gas company, for the lighting of the city, whether by gas or by electricity, was never before so efficiently and so well done as at present. There is yet long life in the gas company, and when artificial lighting shall no longer be its strong point, it will have many other sources of revenue. In electricity, however, we represent the leading energy of this age, and your directors will not be content until our company grows and expands, until it is doing a fair share of the lighting of this city. Not only should we occupy ourselves with the production of energy for lighting purposes, but we should cultivate its use for motive power. I do not think we shall have many years to wait before tramways are principally worked by electricity. I am convinced that as soon as we shall be able to show the directors of our local tramways any advantage in the use of electricity —especially on such horse-killing places as Westgate Hill—they will not be slow to adopt it. Electric motors will also be found useful for the propulsion of machinery in its manifold uses, and I think something more might be done by us to encourage the adoption of electrical motors. The use of our plant, or a large proportion thereof, during the daytime, would considerably reduce our cost of production, and render remunerative to the company the day hours as well as the night hours, upon which we have chiefly to depend for our revenue. Your directors are fully alive to the interests of the public, and so soon as the business of the company shall have attained sufficient volume and the cost of production be reduced, they will recommend a reduction in price, and so bring the use of electricity into still greater popularity. No one who has once used the electric light has any inclination to go back to gas lighting. That there is a great future before us your directors would fain hope. Coming to the results of the recent year's work, the shareholders may be interested to know that during the past year lamps equal to about 4,000 10-candle power lights were connected to the company's mains, and during the same time 15,610 yards of cable have been laid, and 2,430 yards of main and branch piping. The 6-inch main pipe which at the commencement of the company's operations was laid in Forth Banks is now filled up with cable, and in view of the demands which are being received for supply of current it has been found necessary to commence laying another 6-inch main.

Mr. J. R. HALLIDAY seconded the motion, and the report was unanimously adopted.

On the motion of Mr. J. B. SIMPSON, a vote of thanks was passed to the chairman.

Birmingham Electric Supply Company.

THE following is an abstract of the directors' report for the past nine months. The accounts show a profit of £713 16s. 4d., and, taking into consideration the fact that these accounts include the supply during the six summer months, the result cannot but be deemed satisfactory. Of this sum the directors have applied £351 16s. 7d. to depreciation reserve account, and recommend that the balance be carried forward to next year's account. The capital expenditure on buildings, plant, and mains during the nine months amounts to £7,761 16s. 7d., this sum including a battery of accumulators and a fourth engine and dynamo. The demand for the light has been most satisfactory—the total number of 16 c.p. lamps, or the equivalent, on order at December 31st being 5,480, which has since been increased by additions to 6,100. It will be of interest to note the company have now on their books as customers two hotels, five clubs, four public buildings, two institutions, 11 restaurants, 60 shops, two banks, eight insurance offices, 56 general offices. The directors contemplate putting down further plant to meet the increased demand. It is also intended to extend the mains through a portion of the areas allotted to the company last year. There still remain of the company's capital 5,625 shares unallotted, and the directors consider that the time has arrived when it will be an advantage to the company that these shares should be taken up. These will at once be offered to the shareholders, and afterwards to the public, at the discretion of the directors.

Giant's Causeway, Portrush and Bush Valley Railway and Tramway Company.

THE directors' report to December 31st, 1891, states that they are glad to be able to report another large increase in the passenger traffic in the year, the first-class passengers having increased to 9,292 from 8,943 last year, and 7,847 in 1889; and the third-class passengers having increased to 82,406 from 73,859 last year, and 56,822 in 1889; the total for the year being 91,698, with corresponding receipts, amounting to £2,830 4s. 2d., as against a total of 82,802, with receipts £2,579 19s. 5d. in 1890, and a total of 64,669, with receipts £2,338 11s. 7d. in 1889. The goods and mineral traffic amounted to 181 tons, compared with 316 tons in 1890, and the receipts have been respectively £29 1s. 5d. and £41 8s. 11d. The receipts for parcels and miscellaneous traffic have diminished during the year from £77 7s. to £19 19s., so that the total receipts from the revenue account have been £2,895 14s. 7d., as against a total of £2,698 15s. 4d. in 1890. There has, however, been considerable increase on the expenditure side of the account, which shows a total of £1,945 6s. 6d., as against £1,687 12s. in 1890, and £1,732 10s. 9d. in 1889. There is consequently a credit balance on the result of the year's working of £950 8s. 1d., as against £1,011 3s. 4d. in 1890, and £381 18s. 7d. in 1889. This result has again fulfilled the anticipations of the directors, and is traceable not only to the increase in the passenger traffic, but to the alteration made three years ago in the arrangements with regard to the goods traffic, which had previously been a constant source of loss to the revenue. It will be seen, on an examination of the above figures, that the ratio of expenses to receipts, which was 82 per cent. in 1889, and 62 per cent. in 1890, has been 67 per cent. in the past year. The value of electricity as a motive power, when generated by water-power, as compared with steam, continues to be shown remarkably. The expenses of the electrical working amounted to £314 for 19,863 miles run, or less than 4d. per mile, while steam-power cost £635 for 12,280 miles run, or 1s. 0¼d. per mile. The directors regret the considerable increase in expenditure during the year, but they have found it necessary to re-fence the line for almost its *entire length, to prevent accidents* to cattle. They have also paid for the conversion of three waggons into carts out of revenue, and have spent a considerable sum in the renewal of the electrical apparatus, and as the permanent way and steam engines have been kept in complete order, everything will be found in proper condition for the ensuing season.

The directors regret that they are not yet in a position to offer a dividend to the shareholders, nor can they do so until the net revenue account is brought into a more favourable position; but they think it is evident, from the great improvement which has taken place in the finances of the company during the last two years, that the time is approaching when they will be able to do so.

Mr. Stuart and Mr. W. A. Traill are the directors who retire by rotation, and they are eligible for re-election.

The Gülcher (New) Electric Light and Power Company, Limited.

THE fourth ordinary general meeting of the above company, which stands adjourned until February 18th inst., was held at the offices of the company, Battersea Foundry, S.W., for the purpose only of being further adjourned, in order that the accounts, as prepared by the auditor, may be modified, by showing in detail the result of the chairman's visit to New Zealand upon the year's transactions.

Babcock and Wilcox, Limited.—Messrs. Babcock and Wilcox, Limited, notify that the interim dividend is payable at Messrs. Barclay, Bevan & Co.'s, Lombard Street, on Monday, February 15th, at the rate of 6 per cent. per annum on the preference shares and 10 per cent. on the ordinary shares for the six months to December 31st.

The Western Counties and South Wales Telephone Company, Limited.—The warrants for interest on the preference shares of this company for the half-year ended December 31st last, at the rate of 6 per cent. per annum, have been posted, and are payable at the company's bankers—the National Provincial Bank of England, Bristol—on and after the 13th instant.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Feb. 11th.)	Closing Quotation. (Feb. 18th.)	Business done during week ending (Feb. 18th, 1892.) Highest.	Lowest.
250,000£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 — 102	...	...
1,300,980£	Anglo-American Telegraph, Limited	Stock	50 — 51	49 — 50 xd	42½	49½
2,849,510£	Do. do. 6 p. c. Preferred	Stock	89 — 90	88 — 89 xd	88⅜	87⅞
2,849,510£	Do. do. Deferred	Stock	11⅜— 12½	12 — 12½	12½	11⅞
130,000	Brazilian Submarine Telegraph, Limited	10	10⅞— 11¼	10⅞— 11¼	11⅛	10⅞
53,200£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	101	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3¼— 3½	3¼— 3½	3⅜	3¼
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2¼	2⅛
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½— 4½	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	6½— 6⅝	6½— 6⅝	6 1/16	6½
$7,716,000	Commercial Cable, Capital Stock	$100	153 —157	153 —157	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	⅜— ½	⅜— ½	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 6	5½— 6	5⅞	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10 — 11 xd	10½	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16 — 17 xd	17	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 3⅝	3½— 3⅝	...	...
6,000	Do. do. 10 p. c. Preference	5	8½— 9½	8½— 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11 — 11½	11 — 11½	11½	11
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 14⅝	14½— 14⅝	14⅝	14½
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	15⅜
200,000£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	105 —108	105 —108	...	...
1,200,000£	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 — 110	103½	108⅝
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15¼	15 1/16
78,300£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	...	...
276,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	103½	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	107⅜	...
135,000£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	...	...
180,400£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	...	...
201,600£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	90 —102	99 —102	101	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5¾ — 6¼	5¾— 6¼	6	5⅞
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ..	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2⅛— 2⅜	2⅜— 2⅝	2⅜	2⅜
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅛— 3⅜	3⅛— 3⅜	3⅛	3
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	2 — 2¼	1¾— 2	1 13/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅞ — 10⅛	9⅞— 10⅛	10 1/16	9⅞
180,042	Do. do. 6 p. c. Preference	10	14⅜ — 15	14⅞— 15⅛	15⅛	14⅝
150,000	Great Northern Tel. Company of Copenhagen	10	19 — 19½	19 — 19½	...	...
220,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅞ — 8¼	7⅞— 8¼	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9¼ — 10½	9½— 10¼	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21½ — 22	22½	22
200,000£	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42	41½
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½— 4½	3½— 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	2⅝— 2⅞	2⅝— 2⅞	2¾	2⅛
10,000	Do. do. fully paid	5	4⅞— 5	4⅞— 5	4⅛	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8½ — 9	8½— 9	8⅞	8⅜
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅛ — 4⅜	4⅛ — 4⅜	4⅜	4 1/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	13⅛ — 13⅜	13½	13 5/16
15,000	Do. 6. p. c. Cum. 2nd Preference	10	11½— 12½	11½ — 12½	12	...
420,000£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	104 —107	104 —107	106	...
[250,000£	Do. (issued at 5 p.m., all paid)	...	54 — 57	54 — 57	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/16 — 5/16	¼— ⅜	...	...
9,000	Reuter's Limited	8	7½ — 8	7½— 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¼— 8⅜	8¼— 8⅜	8⅜	8¼
7,900	Do. do. do. 7 per cent. pref.	5	7¼— 7⅜	7¼— 7⅜	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3⅜— 4¼	3⅜— 4¼	4¼	4
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	44 — 46	45½	45
150,000£	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —103	101 —104	103½	103
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	80 — 90	80 — 90	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400£	Do. do. do. 5 p. c. Debentures	100	101 —104	101 —104	...	...
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5	4 11/16	4⅝
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	101 — 105	101 —105	...	...
67,007	Western and Brazilian Telegraph, Limited	15	10½ — 10⅝	10½ — 10⅝	10½	10½
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 6⅝	6½ — 6⅝	6⅝	6 1/16
30,364	Do. do. do. 5 p. c. Deferred	7½	4 — 4½	4 — 4½	4½	4 1/16
189,700£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	101 —104	101 - -104	...	...
237,200£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 —104	101 —104	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 1⅞	1⅝— 1⅞	1⅞	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9½— 10	9½— 10	9¾	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½ — 9½	8½— 9½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100£	Do. do. 6 p. c. Sterling Bonds	100	93 —102	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½— 6⅞	5⅞ — 6½	6⅝	5½

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7¼—7⅜.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 4½—5.—7 per cent. Preference Shares of £5 (fully paid) 5¼—5⅜.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅛—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5½—6.—Liverpool Electric Supply Shares of £5 (fully paid), 4⅜—5.—Do. shares of £6 (£3 paid), 2⅝—2¾.—London Electric Supply Corporation, Ordinary (£5 paid), 1—1½.—Do. 6 per cent. Preference, 1½—1⅝.—Manchester, Edison and Swan Company, £9 (£1 paid), ½ — ⅝.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—½.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—½.—Do. Debentures, 103—½.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 1⅝—1⅞.—£5 Preference (fully paid) 3½—3⅝.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

† Quotations on Liverpool Stock Exchange.

BANK RATE OF DISCOUNT.—3 per cent. (January 21st, 2).

IRIDIUM.

THE London Metallurgical Company, Limited, which is electro-depositing iridium, has placed at our disposal the following compilation :—

Smithson, Tennant, and Descotils indicated independently in the year 1803 the existence of a new metal in the insoluble residue left after treating platinum ores with aqua regia. In the following year Tennant announced to the scientific world the discovery of this new metal, which he named "iridium" (from "Iris," the rainbow), on account of the iridescence and varied colours of some of its compounds. The principal mineral in which iridium is found is iridosmine, which consists of an alloy of about 70 to 75 per cent. of iridium with osmium. It is generally found associated with platinum ores, and also in smaller quantities with most alluvial gold.

Iridosmine has a very wide geographical distribution, being found in the Ural mountains, Siberia, East India, Borneo, Australia, in the deep leads of Victoria, Canada, in the gold washings of the rivers du Loup and des Plates, California, in the gravels of the Sierra Nevada, Oregon, South America, in the province of Choco, in Peru, and in the gold washings of Minas Geraes, Brazil. Small quantities are often found in Germany, France, and Spain. It constitutes the principal part of the platinum ores from Katherineberg, Slatonst, Kischtin, Nischna-Tagilsk, and Newiansk, in the Ural mountains ; this locality produces more iridosmine than any other, California standing second.

It occurs mostly as crystalline plate-shaped grains, which are generally very minute, although occasionally they are found as large as a grain of rice. These grains have a metallic lustre of tin-white to steel-grey colour ; they are distinguished by an extraordinary degree of hardness, which varies, according to the percentage of osmium and platinum present, from that of felspar (orthoclase) to that of rock crystal, and occasionally almost to that of the topaz ; they are slightly malleable. The specific gravity of iridosmine varies from 19·3 to 21·12. Alkalies and acids, even aqua regia, have scarcely any action upon it.

The larger grains are utilised for making the so-called "diamond" points of gold pens, which are soldered on with ordinary hard silver solder, and also for bearings for very delicate wheel-work.

On account of its high specific gravity, it remains with the gold in placer washings. This gold, therefore, when melted up into ingots, since it does not alloy with iridosmine, incorporates in its mass the grains of the latter, greatly impairing its value, both for mining and jewellers' purposes. It becomes in this way a great nuisance to the mints, as the sharp edges of the grains cut and ruin the rolls and dies, and produce flaws in the work of the jeweller.

The Russian Government is the greatest sufferer on this account, as the gold obtained from the Ural mountains is rich in iridosmine, which must be separated at great expense before it can be coined. Formerly, the Government used to sell this iridosmine ; but, finding that it was bought up by unscrupulous parties, and used again for the adulteration of gold, it now not only buys iridosmine, to make it an object to the miners to keep it out of the gold, but refuses, or has hitherto refused, absolutely to sell any. There has, therefore, accumulated at the Russian mints large quantities of this metal, which is held by the Government for its own protection.

The separation of pure iridium from the associated metals by the chemical methods, is a matter of very considerable difficulty, and involves a long series of operations. And even when so obtained pure as a powder, it is almost impossible to fuse it to a compact metal, on account of its exceedingly high fusibility. The metal, in a massive state, possesses a white lustre and colour resembling that of steel. In the cold it is quite brittle, breaking under the hammer ; but at a white heat it is somewhat malleable. Although it is brittle, iridium wire has been produced capable of bending into a loop without breaking. It is infusible in the ordinary blowpipe oxyhydrogen flame, its fusing point being about 2,500° C., and is very slightly volatile. It is hardly attacked, even by hot aqua regia. Its atomic weight is 192·75 ; its specific gravity 22·4, and its specific heat ·0326.

IRIDIO-PLATINUM ALLOYS.

In the heat of the oxyhydrogen flame, iridium and platinum unite permanently in all proportions.

The alloy has much the appearance of platinum, but it is less fusible, harder, more elastic, specifically heavier, and more capable of resisting the action of fire and chemical re-agents, all these qualities increasing as the percentage of iridium increases. Their specific gravities are as follows :—

Platinum.		Iridium.		Sp. gravity.
90	per cent. ...	10	per cent. ...	21·615
85	„ ...	15	„ ...	21·618
66·67	„ ...	33·3	„ ...	21·874
5	„ ...	95	„ ...	22·384

Platinum, alloyed with 10 per cent. of iridium, has been adopted by the International Metrical System Convention for the construction of the geodesic standards, and the alloy has given unqualified satisfaction.

It is almost indestructible, and has extreme rigidity, especially in the tube form ; its coefficient of elasticity is very great ; it has a very high density, 21·615, and a most beautifully polished surface can be obtained upon it. It is very malleable, susceptible of hardening, does not tarnish, and has more lustre than platinum. On account of its ductility, it can be rolled out cold to a very thin sheet and drawn to very fine wire. Its expansion coefficients are :—

Before pressing	0·000008864
After pressure with the die ...	0·000009020
After one ignition at 1,300° C. ...	0·000008905
After two ignitions	0.000008896

This alloy is largely used for making platinum dishes, stills, crucibles, and retorts for evaporating sulphuric acid, the iridium rendering the platinum much stiffer and harder, and consequently more durable than the pure metal. Vessels prepared from it when used become very slightly coated with pure iridium, and are then indifferent to mechanical and most chemical influences.

When laid upon copper it serves for metallic mirrors.

An iridio-platinum alloy containing 20 per cent. of iridium has one of the highest known coefficients of elasticity (22·2), whilst its malleability and ductility are almost without limit. It is hardly attacked by aqua regia. It has the hardness of soft steel, and a specific gravity of 21·614. These qualitities make it an admirable metal for standard weights, to which purpose it has been applied.

Alloys richer in iridium than 20 per cent. are difficult to work. A 25 per cent. alloy can only with great difficulty be worked into sheet and wire at a low temperature. The 30 and 40 per cent. alloys can only be worked with great difficulty at a temperature little below melting. They are brittle when cold, and have a grain of great beauty and fineness. Equal weights of iridium and platinum form a brittle alloy, capable of welding to a certain extent.

With gold iridium forms a malleable alloy, having a colour very much like that of gold.

One part of iridium and eight parts of lead form an alloy, which is very ductile, but much harder and whiter than lead.

One part of iridium and four parts of tin form a dull white, easily crystallisable, hard, malleable alloy.

One part of iridium and four parts of copper form a ductile, pale red alloy, which is much harder than copper.

One per cent. of iridium, alloyed with steel, increases its hardness and tenacity, producing a fine grained metal useful for cutting instruments.

USES OF IRIDIUM COMPOUNDS.

The product of the oxidation of finely divided iridium in air, is the sesquioxide, a black powder, used for producing an intense and permanent pure black enamel in porcelain, and a black stain in glass of so deep a tone of shade that the other substances in use for that purpose give, compared with this colour, a brownish hue. A mixture of the oxides of iridium affords a blue which might be useful as a pigment, were it not that it is slightly soluble in water and discolourised by sulphuretted hydrogen.

The aqueous solution of the black crystals of iridium sodium chloride, is used in the analysis of alkaloids, some of which it precipitates, while morphia is not precipitated by it.

In attempting to fuse iridosmine, it has been found by

experimenters that the best results obtained were by means of the oxyhydrogen or electric furnaces; but that with either of these means of fusion they could only work a very small quantity of the metal at a time, and obtain a very small globule. But it was discovered by Messrs. Johnson and Mathers that at a white heat iridosmine fuses with phosphorus, and can then be cast into slabs. The product, phospho-iridium, possesses some peculiarities of its own. In the first place, it is considerably harder than iridosmine, being about as hard as the ruby; retains perfectly its metallic character; is somewhat lighter, due to the addition of 7 to 8 per cent. of phosphorus and increase of bulk, its specific gravity being about 13 or 14; but it is a compact white metal, and is not perceptibly more brittle than iridosmine. No acids attack it. It retains its homogeneity, with perhaps an increase of capacity for polish, and forms some alloys that the mineral itself is incapable of.

In small quantities it alloys with silver, forming the most elastic and hardest known alloy of that metal. With copper it unites in varying proportions, giving a very hard brittle alloy. With small quantities of phospho-iridium a box-metal is produced, admirably suited for applications where the bearing surfaces are subject to intense pressure, as in drill presses, &c. It seems to possess the property of retaining the lubricant between the rubbing surfaces, under conditions of great pressure, better than any other metal, and being hard, resists distortion and wears much better.

With iron, nickel, cobalt, and platinum it forms alloys, seemingly in all proportions, and of the greatest importance. With iron it unites in all proportions, giving a product retaining the properties of pure phospho-iridium to a lesser degree as regards incorrosibility and hardness, only perceptible after large proportions have been added. Slight magnetism begins to make its appearance at once, but the alloy is unaltered by acids and alkalies, and its hardness is such as to turn the best file until the iron reaches 50 per cent. From this point on the alloys become less and less refractory, partaking more of the qualities of iron, but remaining always brittle.

Phospho-iridium can be used for any of the purposes to which iridium and iridosmine have been put, except that it cannot be used for electrical purposes, as it fuses at a white heat.

It can, however, be dephosphorised by heating it to a very high temperature in a lime cupel in an electrical furnace. The whole of the phosphorus is volatilised, and the metal left in a connected mass of the shape of the mould. The dephosphorised metal appears to be very slightly porous, but not to such an extent as to depreciate its value in any of its applications, and will resist as much heat without fusion as the native metal.

The applications of metallic iridium and phospho-iridium, are many. They are used in America for draw plates for brass, gold, silver, platinum, copper, and very fine iron wire, supplanting for this purpose steel and the ruby, being equal to the latter in hardness. The advantages which it possesses are, that it has no "temper" to be drawn, and that it is tougher, and not so liable as the ruby to crack or chip by rough handling or heating.

It is used as knife-edges for fine analytical balances and scales, being superior to the agate, in that they take a finer edge, thereby making a more delicate balance, and not being so liable to crack or break. They have less friction than steel, are not magnetic, and are not corroded by dampness or acid fumes.

Besides being serviceable in drills and graving tools, they are often employed in electrical contact points, replacing platinum, with which it has similar electrical properties. In this case the dephosphorised metal is used. It does not stick or oxidise as platinum does. Some of these points have been in use for a year and a half without signs of deterioration.

Negative electrodes in the arc lamp has been made from the dephosphorised metal. It has been unsuitable for the positive electrode, as the heat is so intense as to partially fuse it; but as a negative electrode in a lamp having carbon as a positive, it answers very well. The heat in the negative is not sufficient to melt it, but simply enough to make it malleable. The lamps, as ordinarily constructed, permit of the hammering of the negative by the positive electrode, and this is sufficient in time to batter the iridium out of shape. The advantages in using iridium in a properly constructed lamp are the unvarying position of the point of light, thus adapting the arc light to conical and other reflectors, without additional machinery, the shortening of the length of the lamp by nearly the length of the usual negative carbon, and the saving in running expenses of negative carbons. By its use also a considerable increase of light is obtained, and the quality is superior, being less glaring. The iridium does not seem to waste or volatilise, for in an experiment in which an iridium electrode was used for 168 hours, there was no sensible loss of weight. Edison and others have experimented with iridium for incandescent lighting, but not with encouraging results.

Besides being used as journal bearings for delicate machinery, anodes for electro-plating with iridium, bearings for magnetic needles, for surveyors, engineers, &c., taking the place of the ruby, it is especially suitable for purposes which demand a metal that will withstand both chemical and mechanical abrasion.

ELECTRIC LIGHTING IN BERLIN.

[FROM A FOREIGN CORRESPONDENT.]

ACCORDING to the *Berliner Börsen Courier*, electric lighting is being extended in Berlin, and is making a marked impression upon the amount of gas consumed. This is obvious at the Berlin Town Gas Works, for during the financial year 1890-91 the increase in production at these establishments for private consumers has been only 2½ million cubic metres, against nearly 5 million cubic metres in the preceding year. The explanation for this small increase in consumption of gas is given in the report of the managing director for the town lighting. He states that it is in part due to the depressed condition of trade which had commenced in the last half-year of 1889, and which was augmented during the year 1890, and which had affected nearly all branches of manufacture and trade; but they had also had to contend with the extensions of electric lighting. In the year 1890-91, the consumption of gas in the four older parts of the town, which form the first new district, viz., Berlin, Alt-Kölln, Friedrichswerder, and Dorotheenstadt, was 7·59 per cent. less than during the preceding year, and probably the only explanation to be given for this was the extension of the electric light, as more than one-third of the electric lamps, which are lighted by the Berlin Electricity Works, are in those districts. The effect of the competition between the two illuminants is still more evident in those parts of the town where gas is delivered by the English Gas Company. According to the statement of this company, 31,953,010 cubic metres of gas have been delivered for private consumption, against 32,687,532 cubic metres in the previous year, and thus there is a decrease in 1890 of 734,542 cubic metres, or 2·25 per cent. as compared with the previous year. This diminution in the amount of gas consumed may also principally be attributed to the augmentation in electric lighting, as the principal district for gas consumption is situated in that part of the town in which the Berlin Electricity works are chiefly displaying their activity. As far as public lighting by electricity in Berlin is concerned, no alteration has taken place during the working year 1890-91.

Including the lamps, which are destined for public lighting, there were provided with electricity from the existing central stations of the Berlin Electricity Works 2,916 arc lamps, 67,457 incandescent lamps, 54 apparatus (*sic*), 35 motors, and 801 installations, up to March last year. There were further independent installations for producing electric light, viz., 170 driven by steam engines, 83 driven by gas engines, making together 253, by which 3,287 arc lamps and 40,801 incandescent lamps were provided with light. The total number of existing lamps is therefore—arc lamps 6,203, incandescent lamps 108,258, besides 89 apparatus and motors. The total number of electric light installations at the end of March, 1891, was 1,054.

In the course of the year 1890-91, the electric lamps have been increased by 31·79 per cent., whilst in the preceding year the increase had amounted to 29·12 per cent. At the end of the year 1889-90, the total value of the existing electric lamps, calculated into gas jets, came out at 13·01 per cent. of all the public and private gas burners provided by the gas works at Berlin, and the value of the existing electric lamps at the end of the same year was 16·83 per cent. of all the gas burners of the town gas works.

MR. TESLA AND THE DREHSTROM SYSTEM.*

By CARL HERING.

As Mr. C. E. L. Brown, in communications to the *Electrical World* and other journals, seems determined to insist that I have neglected the work of Mr. Tesla on rotary current, I wish here to state that there is no one more ready than myself to give Mr. Tesla due credit for his work, and I have always considered him to be an original inventor of the rotary field system, and the first to reduce it to practice, and I believe I so stated it in my articles. If I have at any time failed to give him credit for the extent to which he developed it, it has been because Mr. Tesla has been too modest (or perhaps prudent) to let the world know what he had accomplished, and we ought, therefore, not to be blamed if we do not always know what he has done. When the articles which have caused this discussion were being written, Mr. Tesla's patents were not accessible to me. Just where Mr. Dobrowolsky's improvements begin I have not yet been able to ascertain.

The fact that I have personally tried to persuade Mr. Tesla to write a paper on his work in this field, will show that I am very anxious myself to know just how far he carried his work, and why it was not continued. In justice to Mr. Dobrowolsky, it ought to be said that if Tesla did not publish his researches other than his patents, Dobrowolsky ought to have the credit at least for what he did that was not included in Tesla's patents. Dobrowolsky, though he may have been an independent inventor, admits that Tesla's work is prior to his, but he claims to have made improvements. In my articles I distinctly stated that I did not wish to enter into a discussion of the subject of priority. Dobrowolsky's system has proved itself to be a success; it was natural to assume that he had made some improvements. It must be left to a discussion between Tesla and Dobrowolsky, and not to others, to determine, if necessary, just where the one left off and the other began. The modesty of both of these gentlemen would, I feel sure, lead to a clear understanding.

Regarding the subject of priority, it may be of interest here to say that in a conversation with Prof. Ferraris, last summer, that gentleman told me with very becoming modesty that, although he had experimented with the rotary field several years before Tesla's work was published, he did not think it was possible that Tesla could have known of his work, and he, therefore, believed that Tesla invented it entirely independently. He also stated that Tesla developed it much farther than he (Ferraris) did.

* *New York Electrical World.*

PROTECTION FROM LIGHTNING.

A PAPER on this subject, illustrated by numerous experiments and lantern views, was read by Mr. ALFRED HANDS, F.R.Met.S., before an ordinary meeting of the Society of Architects, held at St. James's Hall, Piccadilly, on Tuesday evening, February 9th, 1892. The President, Mr. W. H. Seth-Smith, F.R.I.B.A., occupied the chair.

The lecturer said:—

Although the increase in electrical knowledge has been great in modern times, very little advance has been made in the knowledge of thunderstorms until quite recently. A few years ago, however, the Royal Meteorological Society appointed a committee to investigate this subject, and two reports have already been published. It was thought at one time that thunderstorms were of an erratic nature; but Mr. Marriott, in the last of these reports, has shown that they consist of atmospheric whirls following similar laws to other cyclonic disturbances. He finds that thunderstorms, instead of travelling at a rapid rate over the country as one continuous storm, consist really of a series of storms following one another, and it is his opinion that the average life of each is not more than about 20 miles. This latter discovery alone is most important. At present we have no really reliable theory as to the origin of atmospheric electricity. Various theories have been advanced; but they all appear untenable, and therefore unsatisfactory. Whatever the cause, we know that the air is always in an electrified state, the potential rising as the distance from the earth is increased. It is probable that clouds act only as accumulators of charge, and that the enormous tension evinced in a thunderstorm is caused by clouds acting inductively on one another. One of the noticeable features of a thunderstorm is the heavy drops of rain which fall, instead of the ordinary fine drizzle. Lord Rayleigh has shown the cause of this by a striking experiment. A jet of water is thrown into the air, and is projected on to the screen by a lantern. The drops of water as they fall are fine; but immediately the jet is electrified by a stick of rubbed sealing-wax being brought near to it, the drops coalesce into large heavy ones, similar to those which accompany a thunderstorm. Another experiment, to which we are indebted to Mr. Shelford Bidwell, F.R.S., shows why thunder-clouds are heavy and appear sometimes of a coppery hue. A jet of steam being projected on to a screen appears of feeble intensity and of a neutral grey tint; but immediately it is electrified, it becomes dense and dark, and assumes, especially near its edges, a peculiar orange-brown hue. In England we are not so liable to thunderstorms as are the inhabitants of some countries, but nevertheless the amount of damage caused by lightning in this country is very great, and is probably far more than most people who do not take any especial interest in the subject would realise. The invention of the lightning conductor was the immediate outcome of Franklin's discovery that lightning was electricity. He suggested that by laying metallic paths on buildings or ships the electric force could be conveyed harmlessly to earth, and that, consequently, damage to such structures could be prevented. The spread of the use of conductors was, however, very gradual, being largely retarded by religious opposition. Increase in scientific knowledge has overcome these prejudices, and now an enormous number of buildings have been provided with lightning conductors. General ideas as to how buildings should be protected from lightning are, however, very hazy, and consequently an enormous number of the conductors in existence are of very little use, and we often hear of cases where buildings, supposed to have been rendered proof against lightning, are damaged. Paradoxical though the remark may seem, the erection of lightning conductors, even of the most approved type, and the protection of a building from damage by lightning, through the use of conductors, may be two very different things. Theoretically, the principle of the lightning conductor is so simple, and based on such well-known laws, that there can be no doubt about its utility; but practically the proper application of lightning conductors is a most difficult matter, and necessitates careful consideration and investigation in order to insure efficiency. If the building to be protected consisted of brick or stone, without a particle of metal in its construction, the matter would be easy, but nowadays, when gas and water pipes are carried about buildings in every direction, besides metal girders and other useful or ornamental metalwork being so largely employed in and on buildings, it becomes necessary to take into consideration the position and quantity of such conducting bodies, otherwise the absolute protection of the buildings is left a matter of chance, and damage may result. A lightning conductor, even if not quite perfect, will still serve to lessen the amount of injury that would result, but this is not sufficient. Protection can be, and should be, absolute, except that rainfall pipes and gutters which are brought into the conductor system may be slightly cracked where the joints do not give good electrical contact. Such nominal damage as this need not be taken into account at all, because it could be avoided, but it is not worth the cost of preventing. My experience in testing shows that at least 70 per cent. of the lightning conductors in England are in such an unsatisfactory condition that they afford only partial protection, and damage might occur to the buildings on which they are fixed, while a large number are so absolutely bad that they would give no protection whatever. It is impossible to lay down any definite set of rules by which conductors can be rendered efficient, because buildings differ as much in their construction as do human beings in their appearance and constitutions; and, therefore, two buildings of somewhat similar design might, owing to complications of internal metalwork, require very different methods of protection. Therefore, in describing some of the principal points that require attention for efficiency—points in which conductors generally fail—I merely advance general principles, and each building must be treated separately according to the peculiarities of its position and construction. A lightning conductor may be said to consist of three parts—the main conductor, the elevation rod and point or crown of points, and the earth connection or portion underground. Undoubtedly, the best and most durable form for the main conductor is flat copper band, sometimes called copper tape or ribbon. Being manufactured in lengths up to nearly 500 feet joints, a source of weakness in a conductor, may be almost dispensed with; while, where absolutely necessary (as for branch conductors), they may be made both electrically and mechanically perfect by riveting and soldering. Its flexibility admits of its following closely the irregular surfaces of buildings, and it is also neater in appearance than any other form of conductor. The purpose of the elevation rod and point is important. Under ordinary circumstances, as an electrically-charged cloud passes across the sky, it causes, by induction, a charge of an opposite nature in the earth and buildings immediately beneath it. Before a discharge occurs, this induction takes place, and where the accumulation

of induced electricity is greatest, or where the atmosphere is weakest (electrically), the lightning will most probably strike. The action of a point is to prevent an accumulation of electricity by dissipating the charge into the air as fast as it gathers, and so a building provided with a pointed conductor should never get into a condition which would allow of a discharge of lightning falling upon it. This action of points may be thus explained. If an insulated metal ball be charged electrically, the charge will be spread evenly over the entire surface, because its self-repulsive power is equal in every direction. If, however, a point is attached to the ball, this repulsive power is no longer equally distributed. The nearer the point the greater is the force repelling the charge in the direction of the apex, till at the extreme point the force is sufficiently great to overcome the resistance of the air, and the neighbouring particles of dust and air becoming charged and repulsed in all directions, the charge on the ball is dissipated. Professor Tait gives a striking instance of how pointed conductors tend to prevent discharge, as shown by the town of Pietermaritzburg, Natal. This district is very liable to thunderstorms, and a great deal of damage was formerly done in the town by lightning, but since conductors have been erected on the principal buildings, lightning has not struck within the town. Thunderstorms occur in the district, but they pass silently over the town, and only discharge their flashes when they have passed beyond range of the conductors. In practice we find that pointed conductors do sometimes receive a discharge of lightning, for the reason that the charge may accumulate too rapidly for the point to dispel it. When one point will not prevent discharge several may, and, therefore, a lightning conductor air-terminal should have one stout central point to receive the flash without melting, if it should strike, and three or four smaller sharp points to facilitate the brush discharge. A church spire or large dome, covered with lead or copper, and provided with a lightning conductor terminating at the point, would be somewhat of the nature of a huge point, and would be less likely to be struck than lower differently constructed buildings. For instance, so long as the conductors on St. Paul's Cathedral are kept in perfect order, lightning would be more likely to fall on one of the smaller pinnacles than on the central dome. One of the most important portions of a lightning conductor is the earth connection. If this is defective the conductor may be absolutely useless, as the discharge might follow some better path, such as a gas or water pipe, and do considerable damage on its way. In ordinary moist soils a good earth connection may be made by attaching to the conductor a large copper plate and bedding it in coke at a sufficient depth to insure sufficient contact with the moisture, or if an iron water or gas main is available, the conductor may be connected to it and an excellent earth will result, but the connection must be very carefully made, or, owing to galvanic action, a bad joint will speedily result. In cases where the soil is dry and there are no mains available, the conductor must be taken to a great depth, so as to reach moist earth, or the plate must be increased in size so as to get a larger area of contact with the earth. Electricity, in passing from a conductor to the earth, meets with a certain amount of resistance, and it is in order to reduce this resistance to a minimum that the plate is required. This is, in fact, a joint in the conductor which requires making good. Prof. Tyndall very aptly described an earth plate as a wide door through which the electricity could escape into the earth. It is entirely a matter of surface of metal in contact with the earth, and nothing is gained by having a thick plate. One-sixteenth of an inch thickness is sufficient for ordinary cases. The area of the plate varies according to the nature of the soil. The area protected by a lightning conductor is comparatively small. A spire may be sufficiently high for a single conductor placed upon it to protect the whole building, but a structure with a number of chimney stacks of about equal height may require a conductor from several or from every stack. These need not, however, be independent conductors, but may be branches to one or more main conductors to earth. One of the reasons for so many points of protection being required is that lightning often divides into several branches before reaching the earth, forming forked lightning, each branch falling on some prominent part of a building. The last requisite for efficiency is the relation of the conductor to other metals inside or outside a building. This is the most important point of all, for whereas a conductor might have defective joints, a rather bad earth connection, or other faults, it might still answer if there were no other metals by which the lightning could find a path to earth. If, however, it is perfect in every other respect, but is carried within sparking distance of a gas pipe or other metal, damage is certain to result. The cause of this is side flash, or lateral discharge from the conductor. If such a spark passes through brickwork to metal inside the building the hole made is generally very small, but the intensity is sufficient to melt and set fire to soft metal gas pipes, or to do other damage. The distance that such a spark will pass depends upon the intensity of the lightning flash, the amount of the metal near the conductor, and whether it is insulated or connected to the earth. It is therefore extremely difficult to say what is the exact distance that such a spark may pass, but with a conductor of good capacity and conductivity, and having a good earth connection, the maximum length of a side flash to a gas or water pipe would be at the most, one and a half yards, and therefore any metal at a greater distance than this should not cause side flash. With insulated metal, if not of large extent, side flash should not be nearly so long. Hitherto it has been too much the custom to regard a lightning rod as a sort of conduit which conducted the electricity, just as rainwater gutters and spouting carry off rainfall from a building, and its physical effects have been somewhat overlooked. We must bear in mind that all the metals about a building are conductors of electricity, and are therefore subject to intense inductive action, so that their condition and effect in the event of the lightning conductor receiving a discharge of lightning must be duly considered. It is no argument against the use of lightning conductors that these physical effects occur. We only require to know their nature and effect in order to guard against them. It is merely a proof that lightning conductors, to be absolutely perfect, require to be scientifically applied. There are two methods by which these effects can be avoided. One is to connect all metals with the conductor. So far as the outside of the building is concerned, this rule holds good—that is to say, any metal near the conductor should be brought into metallic contact with it. As regards the interior of the building, however, this is not always advisable. Apart from the objection there would be to having walls pierced for this purpose, there would be the danger of the connected metal coming near to other metal which was not connected, and which would therefore be at a different potential. For instance, if hot-water pipes were so connected there might be some point where they came near a gas pipe, and there a spark might occur and set light to the gas. A better system is to study the position of the various metals, particularly gas and water pipes, and to so place the conductor that the lightning discharge may be led quietly away to earth without affecting the metals inside the building. After the conductor is fixed these physical effects should be so far borne in mind that the space inside the building near the conductor should be remembered as a dangerous one in which to place metals, and, especially, any alteration to the gas or water system should be carried out with due regard to its effect on the conductor. A necessary way to insure the efficiency of a conductor, but one generally very much neglected, is to have it periodically examined and tested. It should be carefully tested by means of a galvanometer and set of resistance coils to see that the resistance in every part is sufficiently low. Joints may get bad, the continuity of the conductor may even be broken by ignorant workmen repairing the building, and the underground portion may decay. Such faults as these the galvanometer will reveal and allow of their being made good in time. The building should also be carefully inspected to see that no metals have been so placed as to cause lateral discharge. The lecturer, in conclusion, referred his audience to the well known and excellent Report of the Lightning Rod Conference, published by Spon's, which had, he remarked, done much to improve the system of applying lightning conductors.

ROYAL COMMISSION FOR THE CHICAGO EXHIBITION, 1893.

THE following circular has been sent out by the Society of Arts, under the signature of Mr. W. H. Preece, Chairman of the Committee:—

"The Electrical Committee are anxious that the Electrical Department of the Exhibition should contain a good representation from this country. The British Exhibit will include a historical collection as well as the contributions which will be sent in by commercial firms. In addition, it is hoped that a portion of the electric lighting of the Exhibition may be carried out by some British firms, and the Committee think that the arrangements of a complete lighting station on the English method could advantageously be shown at Chicago. From the English point of view it is specially desirable to show how large a share English electricians have had in developing electrical science and its practical applications. The first electrician was an Englishman, Gilbert. It was in England that a practical telegraph line was first worked out by Ronalds in 1816. There are no names more closely associated with the early development of the science of electricity than those of Davy and Faraday. The introduction of telegraphy must inseparably be connected with Cooke and Wheatstone; while the early history of the dynamo would be incomplete indeed without reference to Wilde and Holmes. In England, electricity was first applied to the working of railways, and here nearly all the submarine cables of the world are made. It is hoped that arrangements may be made for showing the fine collection of historical apparatus in the possession of the Post Office, and this will be supplemented by contributions which will be sought from many other sources. On the commercial side, while there is no disputing that practical electric lighting has made greater progress in America than in this country, there is yet much that England can show electricians on the other side of the Atlantic. The domestic uses of electricity and its artistic application are matters in which they confess themselves to be less advanced than we are, and probably many firms who make this a speciality will find it to their interest to show in the Exhibition electrical fittings and the manner of their application. It is especially to be remembered that the Exhibition will be visited by numbers of foreigners, and especially by many persons from our own Colonies, and it is important that English electricians should not miss this opportunity of strengthening and increasing their hold on Colonial trade, since it is quite certain that a strenuous effort will be made by American manufacturers to get this important source of revenue into their own hands.

"Another department in which the United States exhibit will certainly be deficient is that of electric railway signals. The methods on which American railways are worked, do not, as is well known, require the very complete system of signalling apparatus employed in European countries, but this system is now being introduced into America, and will probably supplant the methods now in use. There is, therefore, a very favourable opportunity for manufacturers of this class of apparatus to bring themselves before the notice of American

customers. Another important department which ought not to be neglected is that of electro-metallurgy. Here, also, English inventors will probably find it to their advantage to bring their inventions under the notice of American metallurgists. A special building in Jackson Park will be devoted to the electrical exhibits. The size of this building is 700 feet by 350 feet, enclosing an area of 250,000 square feet. The space provisionally allotted to Great Britain in the building is 20,000 feet. It is understood that all the buildings as well as the grounds will be lighted at night. Applications for space in the British section must be made upon forms to be obtained from the secretary of the Commission, Sir Henry Trueman Wood, at the Society of Arts, John Street, Adelphi, London, W.C. They must be sent in properly filled up, not later than February 29th, 1892, and addressed to the secretary as above."

NEW PATENTS—1892.

1,876. "Improvements in alternating current electromotors." R. KENNEDY. Dated February 1st.

1,878. "Improvements in means or apparatus for protecting underground electrical conductors." F. DAVIS and R. E. B. CROMPTON. Dated February 1st.

1,880. "Improvements in electrical sound producing apparatus." A. B. WOAKES. Dated February 1st.

1,883. "Improvements in electrical telephone transmitters." W. LUCAS and T. A. GARRETT. Dated February 1st.

1,906. "Improvements in shades for electric lamps." J. G. BYWORTH. Dated February 1st.

1,908. "An improved form of automatic accumulator, charging switch, and safety cut-out." T. B. GRANT. Dated February 1st.

1,924. "An electric switch." G. S. GRIMSTON. Dated February 1st.

1,927. "An improvement in secondary voltaic batteries." W. J. S. BARBER-STARKEY. Dated February 1st.

2,008. "Improvements in electric light decorations." E. RATHBONE. Dated February 2nd.

2,012. "Improvements in synchronous electrical signalling apparatus." G. W. HART. Dated February 2nd.

2,016. "An improved block for use in forming conduits for electrical or other cables or wires and for analogous purposes." J. PRICE, jun. Dated February 2nd. *(Complete.)*

2,017. "A new or improved method of and means for making zinc rods for electric bells and batteries." G. TURNER. Dated February 2nd.

2,020. "Improvements relating to electrical signalling on railways." C. W. CATT. Dated February 2nd.

2,026. "Improvements in electric telephones." H. H. LAKE. (Communicated by E. A. Grissinger and T. Grissinger, United States.) Dated February 2nd. *(Complete.)*

2,055. "Improvements in or relating to apparatus for closing electric circuits, for use in connection with position finders or the like." W. L. WISE. (Communicated by G. Bertolini, Italy.) Dated February 2nd.

2,064. "Improvements in the construction of electro-pneumatic pressellcs for electric bells and signals." W. D. PARR. Dated February 3rd.

2,106. "Improvements in heating and welding by electricity." H. HOWARD. Dated February 3rd.

2,109. "Improvements in arrangements and apparatus for telegraph message signalling and other purposes." F. T. HOLLINS. Dated February 3rd.

2,162. "Improvements in automatic arc lamps used in projectors or search lights." R. E. B. CROMPTON and E. A. N. POCHIN. Dated February 4th.

2,163. "Improvements in electric measuring apparatus." R. E. B. CROMPTON. Dated February 4th.

2,198. "Improvements in culverts for electric mains." F. THORNTON and LATIMER CLARK, MUIRHEAD AND CO., LIMITED. Dated February 4th.

2,225. "Improvements in the method of purifying electrolytes containing zinc, relating to or connected with the electro-metallurgic production of zinc." G. NAHNSEN. Dated February 5th. *(Complete.)*

2,254. "Improvements in or connected with the holders of incandescent lamps." W. P. THOMPSON. (Communicated by M. Fuss, Germany.) Dated February 5th. *(Complete.)*

2,260. "Improvements relating to the heating of metals by electricity and to machines therefor." H. H. LAKE. (Communicated by G. D. Burton, A. H. Eddy, and G. S. Briggs, United States.) Dated February 5th.

2,278. "Improvements in and relating to electroliers or pendants and standards for electric lamps." T. C. MOORE. Dated February 5th.

2,283. "Improvements in systems of electrical distribution." B. J. B. MILLS. (Communicated by H. W. Leonard, United States.) Dated February 5th.

2,290. "Method or process of electric riveting." E. E. RIES. Dated February 5th. *(Complete.)*

2,293. "Improvements in the method of connecting together the cells in medical and surgical batteries." D. TURNER. Dated February 6th.

2,312. "Improvements in shade carriers for electric lamps." B. M. DRAKE, J. M. GORHAM, and J. SAWORD. Dated February 6th.

2,329. "Improvements in process and apparatus for bleaching by electrolysis." O. IMRAY. (Communicated by T. J. Montgomery, United States.) Dated February 6th. *(Complete.)*

2,330. "Improvements in electric switches." E. A. GIMINGHAM. Dated February 6th. *(Complete.)*

2,336. "Improvements in dynamo-electric machines." H. DOYER. Dated February 6th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

7,540. "Improvements in electric arc lamps." W. L. WISE. (A communication from La Société Japy Frères et Cie., of Paris.) Dated May 14th. 8d. A lamp with fixed focus, according to this invention, comprises a fixed clock movement mounted on the upper plate of the mechanism, and provided with an anchor escapement in which is actuated a toothed wheel upon which is wound a chain (which may be a pitch chain of brass or copper). This chain is fixed to the upper carbon holder, and also to one of the rods or stems of the lower carbon-holder. This rod or stem may be insulated by means of ivory washers. The weight of the upper carbon holder is greater than that of the lower carbon holder. In this manner it pulls the rods or stems that are guided in the two standards or uprights, and actuates the wheel-work of the clock movement when a balance or rocking beam is by the action of the current caused to release the anchor escapement. 3 claims.

9,130. "Improvements in the means of and apparatus for the regulation of electric currents or their effects." C. R. HEAP and S. SHARP. Dated June 12th. 8d. Consists in altering the lead or position of the collecting brushes upon the commutator to and from their position of maximum efficiency thereupon, through the medium of an electrically controlled fluid pressure. 4 claims.

10,768. "Improvements in shades for electric lamps for displaying goods in shop windows and other places." J. M. M. MUNRO. Dated July 11th. 4d. Consists in piercing the lamp shades (which conceal the light from the eye of the onlooker and reflect it on the goods) with numerous minute holes or perforations preferably arranged so as to enrich the design of the shade or reflector. 1 claim.

10,857. "Improvements in metallic coverings for electric wires." J. M. M. MUNRO. Dated July 11th. 4d. The inventor disconnects the metal sheathing at intervals into sections. Where the disconnections are made the conductor, for a length of, say, half inch or so, is covered by the insulating material only, and no metal. This part is enclosed in a little wooden or earthenware box, which may be filled up with insulating material. 1 claim.

19,811. "Improvements in apparatus for use in propelling vehicles by electricity." F. WYNNE. Dated December 4th. 8d. The inventor connects each separate pair of adjacent road contacts by a conductor, in the circuit of which is one or more solenoids, or a portion of a solenoid, forming part of an electro-magnetic contact making device adapted, when excited, to place each of the road contacts constituting a pair in electrical connection with the main conductor, and on the vehicle to be propelled he provides an electric generator, the poles of which are connected to contacts, that are preferably spaced at a distance apart greater than that of the length of a road contact, and are adapted to travel in contact with the road contacts in advance of the ordinary car contact of the car motor. 5 claims.

CORRESPONDENCE.

Mr. Tesla's Experiments.

While impressions of Mr. Tesla's experiments are still fresh in the minds of those present at the Royal Institution, I ask permission to call attention to one or two points that may refer to the nature of electricity and magnetism.

An insulated conductor was suspended from above the head of the lecturer to the front of the gallery and back again, in two lines slightly converging towards the gallery. When this conductor was placed in the electric circuit, and the room darkened, its whole length glowed with a beautiful violet haze, appearing equally vivid at all parts of the conductor. The haze surrounding the conductor in that space we find imbued with magnetism, when current is passing. Mr. Tesla also connected up two bare wires of circular form, and different diameters, placed concentrically and in the same plane. These, likewise, showed the same violet haze, but directed (like the streamers of the Aurora Borealis) towards each other. In this last experiment the haze seemed less vivid than in the former one, and I should like to know if this is the opinion of others who were present. Of course, the frequency, or potential, may have been changed; or the relative position of the conductors may affect the haze; but,

as we found that a dielectric placed between two sparking terminals facilitated the discharge, it may be that the haze was increased by the use of insulation. If this be so, it is important to know under what change of conditions insulation would cease to facilitate discharge, or vary the magnetic haze, as it might then be used as a test of the quality of insulating material.

My next point is that the violet or magnetic haze would imprint an image on a sensitised photographic plate probably without the aid of a lens, or other light than its own. We know how sensitive such plates are to blue and violet rays of the spectrum; and we know that stars—never seen by man—appear on plates after a lengthened exposure. By calling in, therefore, the aid of another branch of science, we may yet be able to see the exact image of varying electrical or magnetic conditions permanently recorded, and comparable at sight. And we may also hope to acquire further knowledge of these subtle forms of energy.

J. Sinclair Fairfax.

February 15th, 1892.

In reference to your article in last week's issue *re* high tension work, I notice that our names (Pyke and Harris) as having been workers in this field have been omitted, due probably to not having courted publicity in the matter. I enclose copies of our patents for the insulation and cooling of electrical inductoria, and also that regarding vacuum tubes, condensers, &c. The method will work economically and brilliantly with the ordinary tensions and alternation speeds in use for lighting and is a practical and brilliant method of illumination. I am aware of what has been done by others in this field and believe that our patent in regard to transformers is a master one and shows clearly the essential points in the design of high tension transformers for continuous use, transforming a really *considerable* quantity of energy.

Mr. Tesla's experiments, exceedingly interesting and valuable as they are, as pure research, have no commercial value, as induction and retardation with these very high tensions and rapid alternation speeds cause great loss, so that probably any approach to a small percentage of efficiency is absolutely impossible.

L. Pyke.

February 15th, 1892.

Electrical Organ Control.

The organ to which I referred in my letter to you of the 2nd inst. is at present in the possession of Mr. Herskind, of Harrogate, and is under the charge of Messrs. Abbott and Smith, of Leeds. Its electrical parts are constructed in the manner illustrated in Mr. Conti's circular, and, if I remember rightly, each one bears his name.

I am afraid that Mr. A. E. Conti, and I, look at the organ from entirely different points of view, if he sees "very little advantage in the use of electricity for working the stops."

I consider that one of the chief features of my system is the wonderful and hitherto undreamt of flexibility of expression imparted to the "king of instruments" by the application of rapid electrical action to the stops, couplers and swell. The organ, when controlled by the instantaneous "sforzando pedals," "stop keys," and other contrivances, can hardly be recognised as the same instrument, for it acquires, in a great measure, the life and vitality of an orchestra. Further than this, the key action gains a delicacy and sensitiveness when my invention is employed which the 1,500 organists who have tested the instrument at St. John's, Birkenhead, declare has been entirely unknown before. This delicacy of touch cannot be measured by the mere number of times a note will repeat in a minute. I have tested electric organs by a great number of other builders, and in the Schmole and Mols instrument I find in some cases fairly rapid repetition; but in all these instruments it has been easy to strike a key so rapidly that some of its pipes should fail to respond. When playing rapidly reiterated cords on ordinary tracker, common pneumatic, or electro-pneumatic organ with a number of stops drawn, the *full* tone of the pipes is not emitted as it should be, and as it is when the cord is held. Where my invention is made use of, however, the full tone is always emitted. In the Conti action the armature is distinct from the valve, and operates it by means of a short sticker or rod. The valve is of the ordinary construction, and requires a movement equal to one-quarter of the diameter of the opening, if the full area of the same is to be made available. The armature, as Mr. Conti says, weighs three-quarters of an ounce, to which must be added something for the wind pressure. In the Hope-Jones action the armature and valve are one, and the whole thing only weighs $\frac{1}{64}$th of an ounce. This weight is overcome by the pressure of the air, so that the magnet has in reality to operate against only about $\frac{1}{1000}$th part of an ounce. Then, again, instead of using a valve seat with a single opening, I use one having 18 or 20 smaller ones with raised edges. My armature valve has to traverse only a small fraction of the distance necessary in the case of the Conti valve. When it is remembered that by these means the magnet poles are brought a great deal closer to the armature it will be seen at once (the laws of magnetic attraction being borne in mind) that the electric current required is *enormously* reduced at the same time that the certainty of action of the valve is increased. I find that the degree of sensitiveness resulting from this arrangement is so very great that at a pressure of $1\frac{1}{2}$ volts I can wind the magnets to a resistance of 500 (or for that matter I doubt not 1,000) ohms. I know of no other action that would work with certainty if the magnets were wound to even one quarter of this resistance. Mr. Conti speaks of *one* of his magnets (that is, one note) absorbing about 1·8 watts. *The whole of a large four-manual organ* on my system absorbs less electrical energy. In the Conti action I find self-induction with its attendant evil results has been entirely neglected. These evil results have such an important bearing on the question of reliability that I have felt bound in my action to give them serious attention both in the form and winding of the magnets and in the construction of the cable. By the removal of self-induction the sparking at the contacts, which is responsible for so many occasional failures, is removed. The sparking (however slight) by its oxidisation of the points of contact is in a great measure responsible for the bad name which electric actions have acquired in this country. The removal of self-induction has a further advantage in that it secures a promptness of attack and of silence, and a delicacy of action, which are quite impossible of attainment where this defect is present. I should be most pleased, should Mr. Conti be agreeable, to have the two electric actions under discussion thoroughly tested side by side upon neutral ground, the result of the trial being published in your columns, should you think it likely to interest your readers.

Robert Hope-Jones.

February 15th, 1892.

Aurora Borealis.

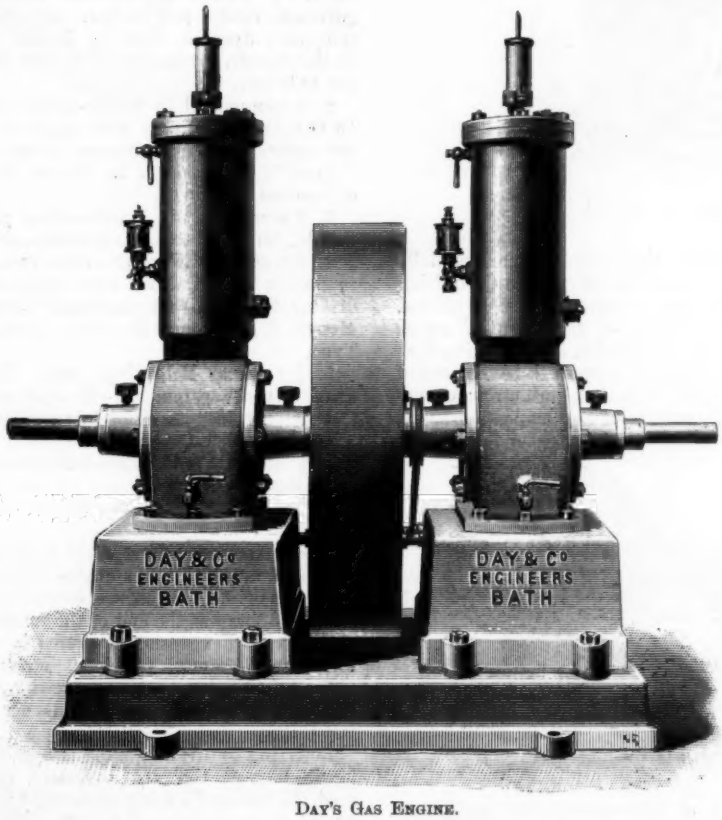
Monday's newspaper brought a Reuter telegram from New York about a brilliant aurora borealis which had seriously disturbed the electrical instruments in the central and north eastern districts of the United States on Saturday evening, February 13th. It was not mentioned, so far as I am aware, that the phenomenon, or something related to it, had been observed here. At 12.40 a.m. on Sunday morning a deep red glow covered the north-west sky, concentrated about west, and extending a little beyond the north, faintly colouring the small clouds there. The whole phenomenon seemed to shift towards the north, moving through an arc of about 45° in the quarter of an hour that I could watch it, the demarcation line remaining all the time remarkably sharp in the west, and also towards the horizon, where the red contrasted beautifully with a sea of azure blue in the north-west. It was a striking sight: a fairly clear sky, the bright, almost full moon, and the red glow opposite with the stars shining through, little affected in their hue—I mean, not appearing greenish as in the days of the Krakatoa sun-glows. I observed a few whitish streaks, three at one moment, too near to one another to say anything about converging—generally only one. There were clouds in the north, and, probably, also near the horizon. By one o'clock the phenomenon had become very faint. When looking again in the same direction a few minutes afterwards, the whole west and north was thickly overcast with apparently stationary clouds.

H. Borns.

Wimbledon, *February 15th*, 1892.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

CONTINUING our articles on the gas engines exhibited, we illustrate the "Day" gas engine, which is remarkable for its simplicity and ingenuity. The system of slides and valve gearing, with their complications of cams, &c., which renders gas engines at once so intricate and expensive, has been entirely abolished in this engine, the only working parts being the crank, fly-wheel, piston, and connecting rod. There is only one valve, and that is automatic. In this engine, the crank chamber is closed in, and as the piston rises a partial vacuum is produced in the crank chamber, and gas and air are drawn in through the passages. When the piston reaches the top of its stroke, the flap valve closes the gas and air inlets, and as the piston descends the explosive mixture is slightly compressed. At the end of the stroke a port is uncovered, so that the mixture rushes into the cylinder. Here it impinges on a fin on the top of the piston, and is projected upwards in the inside of the cylinder, and thus displaces the exploded charge completely. The cylinder is now full of explosive mixture at the pressure of the atmosphere. The piston rises and cuts off both the supply and exhaust, and compresses the mixture. When the piston is near the top of its stroke, it drives the explosive mixture into the ignition tube which fires the charge.



DAY'S GAS ENGINE.

An important feature claimed in this engine is that; owing to the plunger working in an air-tight space, no leakage of gas or waste products can escape into the air except through the exhaust pipe; thus it can be worked in a living-room without vitiating the atmosphere to the smallest extent. For the same reason all the working parts are dust proof, and the engine can be worked under conditions hitherto prohibitive, and thus its field of use is enormously extended. Its capability of reversing by simply stopping and turning the fly-wheel in the opposite direction is also a great advantage for many purposes. There is only one lubricator on the engine, and that is automatic in its action, lubricating all the working parts.

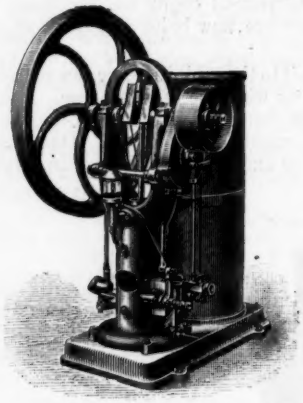
Hitherto, the vertical engine has been made, but we believe that the makers are now building engines of the horizontal type.

During a visit to the exhibition, we saw one of these engines started by a boy with the greatest ease. Engines of small horse-power are connected to dynamos, the voltmeter in each case showing remarkable steadiness. Our illustration shows the twin type of engine, which is made in several sizes.

In this engine an impulse is obtained twice to every revolution, and the cranks and pistons being balanced by one another an extraordinary degree of steadiness is obtained. Though the first cost is somewhat higher than the ordinary type, it is said that considerable economy in working is obtained by using this type. As one engine practically acts as a fly-wheel to the other, the usual heavy fly-wheels are dispensed with, which in itself is a very important advantage. Messrs. Llewellin & James, of Bristol, are the makers of this engine.

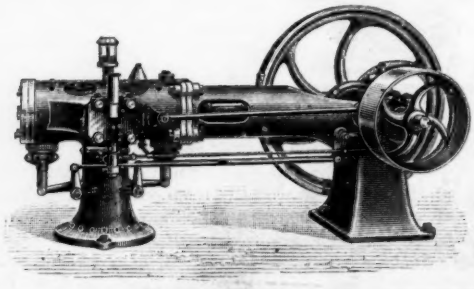
At Stands 67 and 68 in the machinery section, Messrs. Dick, Kerr & Company, Limited, of 101, Leadenhall Street, E.C., and Britannia Engineering Works, Kilmarnock, have a very fine exhibit of their well-known single and double-acting gas engines. They have paid special attention to electric lighting requirements, and have produced an engine which is claimed to be unrivalled for steady running. Their double-acting engine is the only one of the kind in the market—the whole of the operations are performed in one cylinder, impulse being obtained from each end of the cylinder alternately. The result is extreme regularity of speed, and we are assured that the engines are as economical as they are steady. It will perhaps be remembered that in the tests made by the Society of Arts, two or three years ago, these engines met with great approbation, and Profs. Kennedy and Jamieson, after exhaustive tests, concluded that the

engine was a most satisfactory one. The cylinder of the "Griffin," contrary to the method of the customary gas motor, is closed at the front end like that of an ordinary steam engine, and the engine is "double acting," being, in fact, the only gas motor of this type made. The natural result of this double action is that the engine receives an impulse alternately from each end of the cylinder. Economy



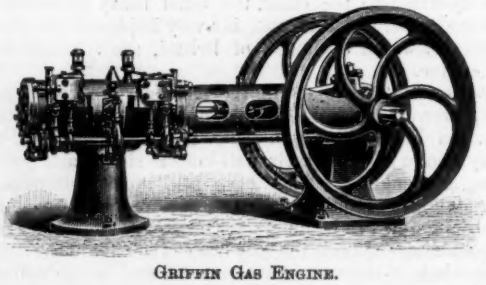
GRIFFIN GAS ENGINE.

in working is thus secured, and the engine rendered specially suitable for electric lighting and kindred purposes requiring steadiness of running. The cycle, or succession of operations, as they take place in the cylinder of the "Griffin," are as follows: Taking one end of the cylinder, and assuming that an impulse has just taken place, the piston will have travelled to the other end of the cylinder; on the return stroke the exhaust valve, which is at the back end of the compression space,



GRIFFIN GAS ENGINE.

opens, and the products of the explosion are swept out. The piston now moves forward again, and, by means of the admission valve, draws in a charge of atmospheric air, which on the return stroke is also swept out, carrying with it any residue of exhaust products left in the cylinder from the exhaust stroke proper. The piston now goes forward for the third time, and draws in an explosive charge of gas



GRIFFIN GAS ENGINE.

and air, which on the return stroke is compressed into the clearance space, where at the proper moment it is fired by an ingenious arrangement of travelling light. The cycle thus gives an impulse every three revolutions of the crank-shaft; but as a similar set of operations takes place alternately at the other end of the cylinder, an impulse is obtained for every one and a half revolutions; an arrangement possessing all the essentials for steady running. Any one part of the "Griffin" can be detached for examination and repair without interfering with the rest, and all the mechanism, being very direct, is in full view of the attendant. Externally it is extremely neat, showing no signs of "dead" metal in the framing—a matter worthy of notice, since these engines are often worked on upper floors of buildings, and carried through narrow and inconvenient staircases. The cylinder framing and pedestals can be readily separated from each other and taken up singly, and, by screwing up a few nuts, re-united into a seemingly solid structure, which is eminently constructed to comply with all the exacting conditions to which motors are frequently subjected. The following are the particulars of the exhibits:—

1. 20 nominal H.P. double-acting gas engine, indicating 50 H.P., fitted with improved tube ignition, high speed governor, mechanical starter, &c., and driving a 25-unit compound dynamo, built by Messrs. Andrews and Preece, of Manchester, by means of a new patent Schultze woven raw hide belt.

2. 6 nominal H.P. double-acting gas engine, indicating 13 H.P., with ordinary slide ignition, high speed governor for electric lighting, driving direct a 5-unit compound "Tyne" dynamo, built by Messrs. E. Scott and Mountain, of Newcastle-on-Tyne.

3. 2 nominal H.P. double-acting gas engine, indicating 5 H.P., driving direct two dynamos, one from each fly-wheel.

4. 3 nominal H.P. single-acting one high speed gas engine, indicating 7 H.P., fitted with improved tube ignition, and driving direct a 2-unit compound "Tyne" dynamo, built by Messrs. E. Scott and Mountain, Limited, of Newcastle-on-Tyne.

5. ¾ nominal H.P. single-acting high speed gas engine fitted with new patent cut-off valve gear and tube ignition, and driving an "Excelsior" dynamo, made by Oppermann, of Clerkenwell, E.C.

6. ½ nominal H.P. single-acting vertical type gas engine, with water vessel combined on one bed plate, driving an "Infant" dynamo, made by Messrs. Austin Myers & Co., of Leeds.

Messr. Alexander Burt & Co. show the Acme gas engine. The chief novelty in this engine is the method of obtaining expansion of the fired charge, beyond the volume occupied by the mixed gases at the end of the intake portion of the cycle.

The desired expansion is secured in a simple manner, and the exhaust is almost noiseless. Moreover, the temperature of the exhausted gases is so reduced by the cooling effect of the expansion as to remove all danger of fire from a heated exhaust pipe.

Referring to the engraving of a 2 H.P. (nominal) engine, it will be seen that two cylinders, pistons, and shafts are used, the two shafts being connected by toothed wheels, which are geared in the ratio of 2 to 1. The piston of the cylinder seen on the right, which is connected to the slow moving shaft, sweeps a less volume than the other does, besides making only half the number of strokes. The smaller volume is secured either by shortening the crank or lessening the diameter of the cylinder, or by the two combined.

The two wheels are engaged, so that when the fast moving piston (on left) is at its outer and inner dead points, the other is distant from its dead points by a distance corresponding to a motion of about 45 degrees of its crank, an amount of travel corresponding roughly to one-seventh of the whole stroke.

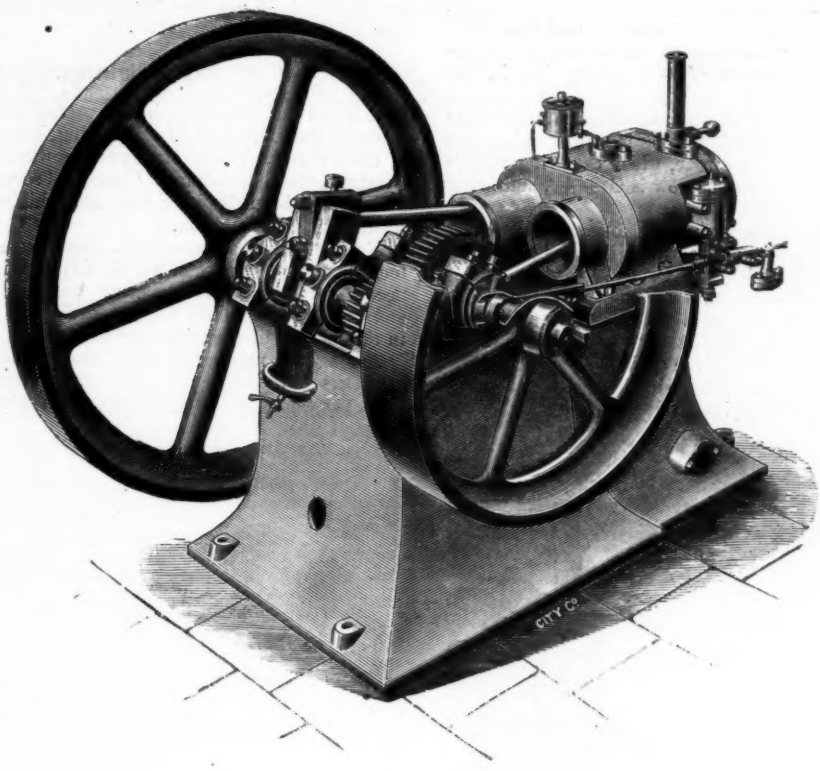
This piston regulates the firing and the exhaust by having the firing tube inserted through the cylinder at about one-seventh of its stroke from the inner dead point, and having ports opening from the cylinder at the outer one-seventh.

Thus only one valve is required, namely, an automatic lift valve for admitting the charge of gas and air, and for preventing the formation of a partial vacuum in the cylinders, when the engine misses an explosion, by being governed.

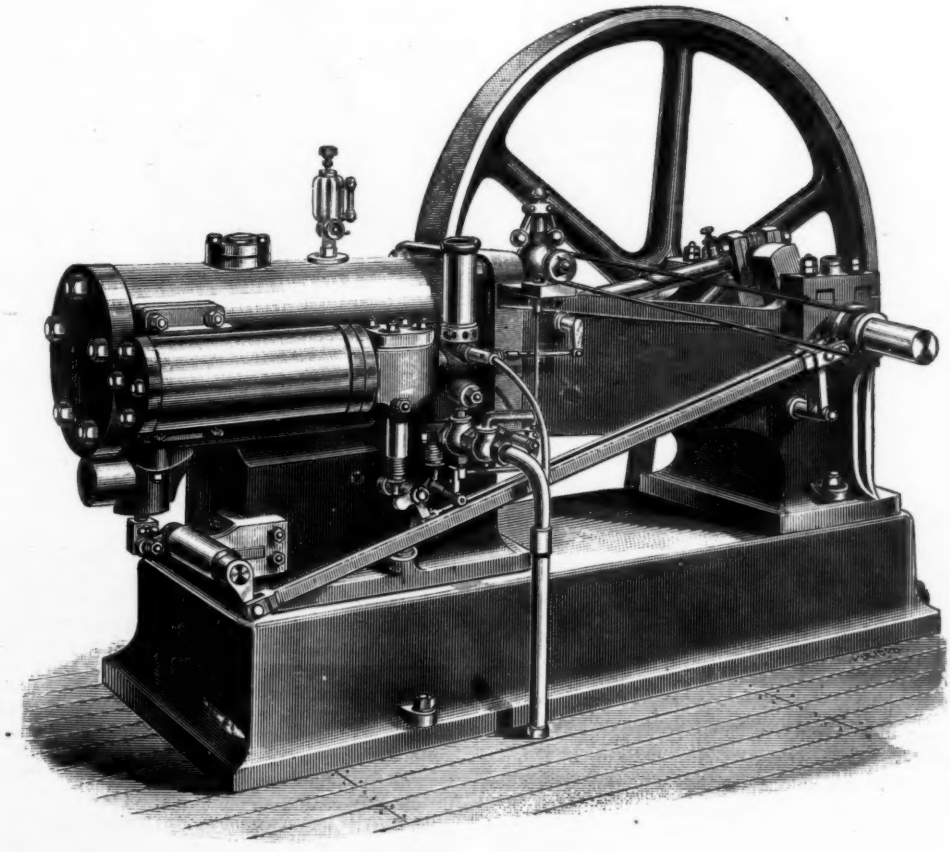
Mr. W. T. Rowden, B.Sc., describes the cycle as follows:—

Suppose the engine to have completed an exhaust. The main (left) piston is now quite in, and the other returning in, having just closed the exhaust ports.

Let "V" be the volume swept by the main (left) piston, "v" that by the other, and "C" the amount of clearance if both pistons could be fully in at the same time.



ACME GAS ENGINE.



THE TRENT GAS ENGINE.

We start with a volume C + $\frac{6}{7}$v.

1. The main piston takes an out-stroke, and the other returns in from about one-seventh to six-sevenths of its in-stroke. The volume now is V + C + $\frac{1}{7}$v, that is, the intake has been V − $\frac{5}{7}$v.

2. The main piston makes an in-stroke, and the other completes the remaining portion of its in-stroke and makes about one-seventh of its out-stroke, where the firing tube is inserted. The compressed volume now is C + $\frac{1}{7}$v, and firing takes place.

3. The main piston makes an out-stroke, and the other also travels out for about five-sevenths of its out-stroke, thus expanding to a volume V + $\frac{5}{7}$v + C.

4. The exhaust ports are now uncovered by the right-hand piston, and whilst the main piston returns, this completes the last one-seventh of its out-stroke, and returns one-seventh in, thus completing the cycle.

The governor is a compact and simple one, and actuates the rod shown leading to the inlet valve.

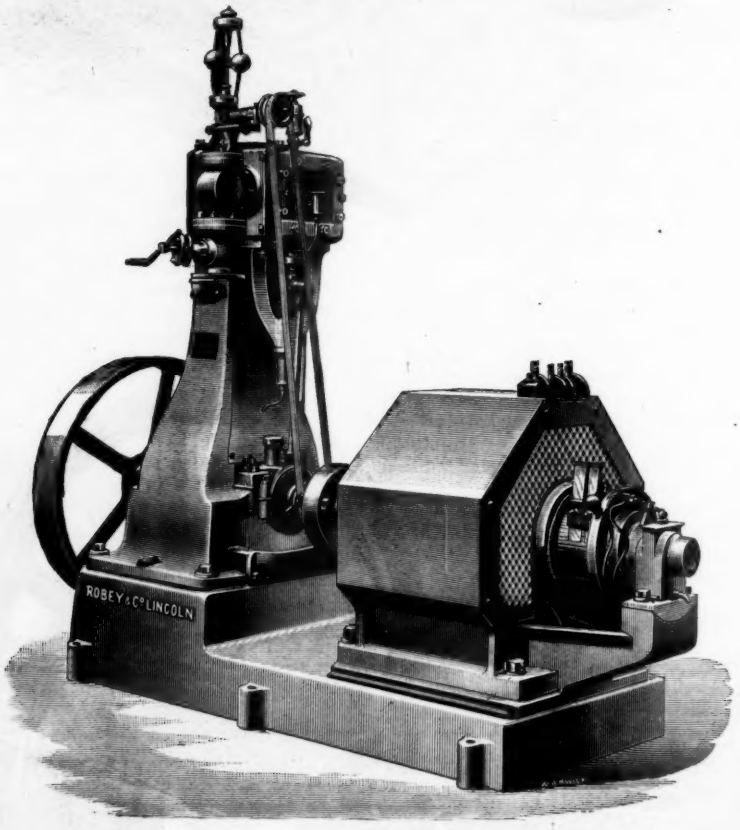
the engine of 12 nominal, which drives with perfect steadiness a four horse load dynamo.

Ship Lighting.

It is not our intention in the present article to describe in detail the exhibit of Messrs. Laing, Wharton and Down, of Bond Street. This company shares with the Construction Syndicate the Entertainment Court, and so well have the plant and fittings been displayed that the exhibits form a distinct feature of the Exhibition.

Messrs. Laing, Wharton and Down have given much attention to the requirements of ship-lighting, such as the necessity of economising space occupied by machinery, and employ a specially trained staff with large experience in this branch of electrical engineering.

Among the number of ship installations on which their engineers have been employed we may mention the Government troopships *Malabar*, *Jumna*, *Euphrates*, *Serapis*, *Croco-*



MESSRS. LAING, WHARTON & DOWN'S SHIP LIGHTING PLANT.

The Trent Gas Engine Company are exhibiting a 12 N.H.P. Trent gas engine, indicating 35 H.P., driving dynamo for Sunbeam lamps, glow lamps, and small electric motors; a 1½ N.H.P. Trent gas engine, indicating 2½ H.P., driving Laurence Scott & Co.'s dynamo for arc lamps.

The Trent gas engine is a slow speed low pressure engine, with one fly-wheel. The explosion is silent, and takes place in a special explosion chamber in which there are no working parts. There is only one cylinder and one piston, which are carried at the two ends of the engine. It is similar to a steam engine, in having one crank. The working parts consist of the piston and steel valves, and are easily accessible. An impulse is received at every revolution. The ignition, controlled by a small positive-acting valve, is absolutely reliable at all speeds, and cannot take place prematurely. These engines are specially built for electric lighting purposes, and their capabilities in this direction are shown in the case of

dile, ships of the Peninsular and Oriental Company, the Orient and Pacific Steam Navigation Company.

In their ship lighting dynamos they claim an absence of external waste magnetic field, owing to the superiority of the arrangement of the magnetic circuit; great simplicity of design and small attention necessary to run; slow speed, if desired, and compactness.

At the exhibition are shown two specimens of direct coupled ship lighting plants, the larger consisting of double cylinder, vertical, high speed engine by Messrs. Robey and Co., of Lincoln, driving a 4 pole "Special" dynamo capable of sustaining, at a speed of 350 revolutions per minute, 400 incandescent electric lamps of 16 candle-power each, with a steam pressure of 120 lbs. per square inch. The smaller, a similar plant with single cylinder engine, capable of sustaining, at a speed of 325 revolutions per minute, 60 lamps of 16 candle-power each; and a steam pressure of 50 lbs. per square inch.